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A New Mississippi River Dredge—Correction—The Cement for the Melan Bridge at Topeka, Kan.—Noisy Brick Pavements.

THROUGH TRAINS OVER THE BROOKLYN BRIDGE, connecting with the elevated railways and street car lines on either side, were considered at the meeting of the Bridge Trustees Oct. 26. Mr. Wurster, mayor of Brooklyn, spoke strongly in favor of some definite steps being adopted instead of continually postponing consideration of the question. It was eventually decided to employ three engineers, who, together with Mr. C. C. Martin, the Chief Engineer, will form a board of engineers to examine the bridge and settle once for all the feasibility of through and continuous traffic; the sum of $3,000 was ordered appropriated for this purpose. Two engineers are to be selected by the mayors of the two cities, and the third one by the vice-president or president of the Board of Trustees. Mr. Howell, the president, has appointed Mr. L. L. Buck, M. Am. Soc. C. E., who is chief engineer of the new East River Bridge.

PNEUMATIC TUBES FOR CARRYING MAILS are to be laid across the Brooklyn Bridge, connecting the main post-offices of New York and Brooklyn. There will be two 8-in. tubes, the terminals and power plant being in the two post-offices. The right to lay the tubes has been granted to the New York Mail & Transportation Co., at a rental of $1.000 per year for five years. The work is to be done under the supervision of Mr. C. C. Martin, Chief Engineer, and is to be completed by March, 1897. The company will receive $14,000 per year from the government.

AN EAST RIVER TUNNEL RAILWAY to connect New York and Brooklyn is now proposed by the New York & Brooklyn Ry. Co. The tunnel tracks are to come to the surface at each end, to afford direct connection with other lines. The proposed tunnel is to run from the junction of Myrtle and Willoughby Aves., Brooklyn, across the East River, in almost a straight line, parallel to the Brooklyn Bridge, to the New York terminus, at Park Row and Ann St. It will be lighted by electricity. The general plan is to have two tracks in two tunnels, thus making a four-track line. These tunnels will be 8,700 ft. long, and the two tunnels together will be 45 ft. wide. The grade at either end will not be more than 4%. This is the project which has been brought forward from time to time by Mr. B. S. Henning, who is President of the company. The directors include Emerson McMillin; Silas B. Dutcher, President of the Hamilton Trust Co., of Brooklyn; J. N. Partridge, President of the Brooklyn City & Newtown Ry.; Henry W. Slocum, former President of the Coney Island & Brooklyn Ry., and James C. Church, Secretary of the Nassau Electric Ry.

THE NEW EAST RIVER BRIDGE contract for the New York tower has been awarded to Patrick H. Flynn, of Brooklyn, for $367,000, under a bond of $250,000. The stone is to come from the New Jersey quarries of Jesse S. Carman. The engineer's estimate for building this tower was $477,000.

AN AIR-BRAKE PATENT SUIT is now being argued in the U. S. Supreme Court, though that court does not often take up patent suits. The case is that of the Westinghouse Air-Brake Co. against the Boyden Brake Co. The case was carried to the Supreme Court on a writ of certiorari from the appellate court of the fourth circuit at Richmond.

THE LOOP TERMINAL of the Chicago elevated railways, described in our issues of July 16 and Aug. 20, is now to be pushed to completion, the Supreme Court having decided that the property owners along the line cannot prevent by injunction the building of the line.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and the most serious accident which we have had to record for some time, was a head collision, Oct. 25, on the St. Louis & San Francisco R. R., near Meramec Highlands, St. Louis, Mo. The second section of a westbound excursion train for St. James, Mo., had orders to stop at the Windsor siding to pass an eastbound accommodation train from Valley Park. The engineman, however, tried to reach the next siding, with the result of causing a collision, in which eight persons were killed and 16 injured. The eastbound train was composed of a combination passenger and baggage car and one day car. The westbound train was composed of a combination baggage and refreshment car, and ten day cars. The first two cars of this train were telescoped and smashed, and in them occurred most of the casualties.

TWO RAILWAY DRAWBRIDGE ACCIDENTS are reported. On Oct. 20, while the drawbridge which spans the guard lock of the Morris Canal, at Dover, N. J., where the canal crosses the Rockaway River, was being raised to allow a canal boat to pass, a work train on the High Bridge branch of the Central R. R. of New Jersey backed down upon it. The rear car, a combination car, filled with laborers, ran half-way up the draw, which was tilted at an angle of about 45°, causing the bridge to fall, but nobody was injured.——On Oct. 26, the theater train from New York, on the New York, New Haven & Hartford R. R., was derailed by the derailing switch at the drawbridge at South Norwalk, Conn. Owing to the speed of the train, it ran through the sidetrack and the engine and baggage car went down a 50-ft. bank, but nobody was hurt. An investigation will be made to ascertain whether the accident was due to a wrong signal or to a failure to observe the signals.

A RUNAWAY CAR on a cableway at the works of the Pioneer Electric Power Co., near Ogden, Utah, struck one of the posts and two persons were thrown out and injured. The accident was due to a failure of the brake on an incline 300 ft. long.

THE COLLAPSE OF A RAILWAY BRIDGE on the Chicago Great Western Ry., over the Platte River, occurred Oct. 21, while a freight train was crossing. Three men were killed and 11 cars were wrecked. A passenger train had crossed the bridge only a few minutes before.

AN EXPLOSION OF DYNAMITE occurred, Oct. 26, at the works of the Acme Powder Co., near Pittsburg, Pa., and two men were killed. It is said that 1,000 lbs. of dynamite exploded in the packing house.

A BIG QUARRY BLAST WAS FIRED at the Long Cove quarries of Booth Bros., in Maine, Oct. 23. About nine tons of powder were used and 500,000 tons of rock were lifted and split up. A shaft had been sunk 64 ft. deep, and two tunnels were run from this, with a cross tunnel at each end.

THE RESPONSIBILITY FOR THE BUILDING ACCIdent at 1078 Madison Ave., on Sept. 26, has been placed by the coroner's jury on Frederick H. Hawkins, who superintended the construction of the building; on Anton D'Andrea, the stone mason, who built the foundation walls; and on the Building Department. The jury recognized the difficulties under which the department labors, and added the following rider to the verdict:

We hold responsible the Department of Buildings of the city of New York for insufficient inspection. We deplore that a lack of finances tie the hands of the Department of Buildings, while the law calls upon it to perform inspections, which, under the present conditions, are practically a physical impossibility to the available force.

THE EXCESSIVE COST OF ELECTRIC STREET lighting in New York is explained, as follows, by the Commissioner of Public Works: The subways, though under the control of the city, are owned by a private corporation charging rentals. Under the terms of the contract the city can place its police, fire and other wires in these subways free of charge; but the electric light companies pay $1,000 per mile per year for the use of these subways, and must contract for five years, though their contract with the city for street lighting is limited to one year by statute. In some parts of the city, the lighting companies cannot afford to extend their system under the terms imposed. In Boston, 2,000 c. p. arc-lights are furnished for $124 to $127 per light per year, and in Philadelphia the cost is $128. In New York, a 1,200 c. p. light costs from $146 to $182 per year. The Commissioner of Public Works recommends legislation enabling the Gas Commission to extend the time of its contracts, and he further believes that companies should be allowed to use subways free of charge, where such subways were employed exclusively for street lighting.

PAVING BLOCKS MADE OF MEADOW GRASS, says the Atlantic City "Union," are now being made in that city. The inventor is Rev. J. H. Amies, a resident of Atlantic City, N. J., and the meadow grass, impregnated with oil, tar and resin, is pressed into blocks measuring 14 × 21 × 6 ins., and then bound with iron straps. These blocks are said to weigh 40 lbs. per cu. ft., and can be made denser if desired. The claim is made that the street pavement of these blocks is noiseless and elastic, resists wear well and is impervious to heat and cold. Its manufacturers guarantee its life for five years. A plant was erected in Norfolk, Va., about three years ago and experiments were made with the pavement in Norfolk and Richmond and the results are claimed to have been very successful. The grass used is the ordinary wiry salt meadow grass, common along the Atlantic coast.

FIFTH AVENUE, NEW YORK, carries the largest traffic of any street in the United States, says the Commissioner of Public Works of that city. This traffic is greatest between 28th and 42d Streets, where 6,272 vehicles, loading 10,165 tons, pass daily. Broad Street, Philadelphia, in front of the Pennsylvania railway station, comes next in daily traffic, according to Commissioner Collis. The better water supply of the downtown district has necessitated the laying of two 48-in. mains on this avenue, and this work is now in progress. Sewers are also wanting on parts of this highway and these gaps are now being filled up. The fact that Fifth Avenue has been torn up is taken advantage of to replace the stone block pavement with asphalt, from Washington Square to Central Park. This paving is authorized under the appropriation of $1,000,000 for laying the water mains which also provides for repaving the trenches; the repaving over the new sewers is paid for by the property-owners and the balance comes from the annual appropriation for new paving. The asphalt pavement is to have a crown of only 4½ ins. instead of the 7 and 8 ins. of the old stone pavement.

THE NEW YORK CANAL IMPROVEMENTS, authorized under the late $9,000,000 appropriation for this purpose, are reported upon as follows by Mr. A. R. Smith, Secretary of the Executive Canal Committee: With the funds at the disposal of the state three modern double-length steel lift-locks will be built at Cohoes, Lockport and Little Falls, and it is not yet decided whether there will be, at Newark, one double-length steel lift-lock, or two double-length ordinary locks, in place of the present three single-length locks. The Erie Canal will be 9 ft. deep throughout, instead of only in the prism of the canal, as contemplated in the bill, and the depth of 9 ft. will be obtained over all existing permanent structures, allowing boats to load to 8 ft. instead of to 7 ft., as in the bill. These provisions allow for boats 115 ft. long and carrying 60% more load than at present, with a full foot of water under their keels. The amount of money now available is $4,000,000, and power to issue the remaining $5,000,000 in bonds is to be asked from the next legislature. The canals to be improved include the Erie, Oswego and Champlain main canals, aggregating 640 miles of navigable canal, 84 miles of navigable feeders, 261 locks, 33 aqueducts, and 1,100 bridges and other structures. For this work over 1,000 surveys, with maps and blue-prints, have been already made. The work to be undertaken immediately is as follows: Oswego Canal—Raising the Phoenix, Bradlock, Minetto, High and Oswego dams about 29 ins. each; the improvement of the Ontario Level, and the lengthening of Lock 18, at a total estimated cost of $159,000. Champlain Canal—Excavation and improvement between Lock 5 and the Waterford side cut; between Locks 6 and 7, and the level between Fort Edward and Fort Ann; at a total estimated cost of $409,758. Erie Canal; Western Division—Excavation, largely through solid rock, at Buffalo and Lockport, and the rebuilding of the Cartersville waste-weir; estimated cost, $1,025,856. Middle Division—From Oneida County line to Lock 51, and lowering of the bottoms of Locks 46, 49 and 50; total estimated cost, $780,973. Eastern Division—Improvements costing $744,099. The total estimated expenditure on the above canals, as given, amounts to $3,117,692. The total probable quantities, as given upon the bidding sheets, are as follows for the principal items: Total excavation, 3,261,077 cu. yds total iron and steel, 1,725,491 lbs.; lumber, 6,475,520 ft. B. M.; 33,855 cu. yds. concrete; wall masonry, 235,150 cu. yds.; lining, 158,930 cu. yds.; channeling, 263,150 cu. yds.; embankment, 209,540 cu. yds.; puddling, 26,265 cu yds.; piling, 104,265 lin. ft.

A BRICK CHIMNEY IS BEING MOVED about 1,000 ft., at Bridgehampton, L. I. This chimney is 75 ft. high and weighs about 100 tons; it belonged to a hotel destroyed by fire and is to form part of a newly built structure. The contractors for the work are William and Charles P. Topping, of that place.

STRUCTURES ON THE SAN FRANCISCO & SAN JOAQUIN VALLEY RY.

(With inset.)

The line of the San Francisco & San Joaquin Valley Ry., which is now under construction, will extend from Stockton, Cal., to Fresno, and Bakersfield, a distance of about 250 miles, and is already completed as far as Fresno, while at Stockton there is connection with river steamers for San Francisco. The first train entered Fresno on Oct. 5. The railway parallels some of the lines of the Southern Pacific Ry., having one of that rival's lines on each side (about 12 miles away), nearly all the way to Fresno, but it is to open up a large local traffic in the wheat and fruit growing district of the San Joaquin Valley. Mr. Claus Spreckels is at the head of the enterprise. Mr. Wm. B. Storey, Jr., M. Am. Soc. C. E., is Chief Engineer, and during a visit to San Francisco last summer we obtained from Mr. Storey the blueprints, photographs and information made use of in the preparation of this article.

The railway traverses a fairly level country, and has easy grades, the maximum grades being 0.3%. The earthwork is mainly adobe soil and hardpan, the latter requiring a considerable amount of powder to break it up. Grant Bros., of Los Angeles, and San Francisco, were the contractors for the grading.

The generally flat country of the valley is intersected by a number of deep, wide ravines, or river channels, which necessitate a considerable amount of bridge and trestle work. These structures are mainly of Oregon pine. All the bridges were designed by and all bridge material was purchased by the chief engineer of the road, the contract for the work of erection being let to the San Francisco Bridge Co.

Fig. 1 shows the bridge and trestle across Dry Creek, and represents the general type of trestle approach to the bridge spans. In this particular case the right hand bank falls away sharply at the pile abutment to the level of the stream crossed by the Howe truss deck span. The trestles have four-post bents of squared timber, and a noticeable and commendable feature in the design is the ample provision of transverse and longitudinal diagonal bracing, the latter bracing being far too often omitted in structures of this kind, leaving the stringers and the waling-pieces to carry all the longitudinal strains. Fig. 2 is a view of the bridge over the Stanislaus River, having one through truss channel span, and deck trusses for the approach. The piers are of pile clusters, sheathed with timber to protect them from floating driftwood, etc.

Fig. 3 (on the inset sheet) gives the details of the construction of one of the three 150-ft. Howe truss deck spans over the San Joaquin River. The lower chord is continuous over the three spans, the upper chord is broken over each pier. The panel length is 12 ft. 6 ins., and the truss depth (between chords) is 20 ft. The truss rods pass through tubes or sleeves in the chords, and the joints in the lower chord-members are spliced by eyebars. The truss has a camber of 3 ins., 2 ins. of which are taken out by sizing the ties over the stringers, and 1 in. of camber is left in the track. At each panel point are the floor timbers 6 × 18 ins. and 8 × 18 ins., 20 ft. long, carrying track stringers 6 × 14 ins., on which again are the ties, 8 × 8 ins., 8 × 9 ins. and 8 × 10 ins., 9 ft long. There are inside guard rails of the same weight as the track rails and set 8 ins. clear from them, while the guard timbers 6 × 8 ins. (set flat) are on the outside, 8 ins. from the track rails. The guard timbers are bolted through tie and stringer at every fourth tie, these ties being boxed out 1 in. for the guard timbers, while at the other ties the guard timbers are boxed out 1 in. A horizontal lateral bracing connects the upper chords and the lower chords, while at each panel point is a vertical diagonal sway bracing, the pieces of which (in the larger sizes) are boxed out ½-in. at their intersection.

The combination passenger and freight stations of this railway are of simple and attractive design, and conveniently arranged, as will be seen by the plans and elevations in Fig. 4 (on the inset sheet). On the ground floor, all under one roof, are an open waiting room, a closed waiting-room and an agent's office and storeroom; then comes a baggage-room and then a large freight room, the latter having a raised platform on three sides. The middle part of the building is carried up to form a second floor with living accommodation for the station agent.

The track is laid with rails weighing 62½ lbs. per yd., rolled by the Bethlehem Iron Co. and the Homestead works of the Carnegie Steel Co. They are of the Am. Soc. C. E. section, the dimensions being a mean between those of the 60-lb. and 65-lb. recommended sections. There are 16 redwood ties to a rail length of 30 ft., with Servis tieplates on every tie. The rails are laid with suspended broken joints, spliced by angle bars and four bolts. The ballast is of gravel. The switches and frogs were designed in the chief engineer's office and built by the Pacific Rolling Mills and other coast works, being a new class of manufacture in that part of the country. The engines were built by the Baldwin Locomotive Works, of Philadelphia, Pa., and the cars by W. L. Holman, of San Francisco, Cal., and the Ensign Car Mfg. Co., of Huntington, W. Va.

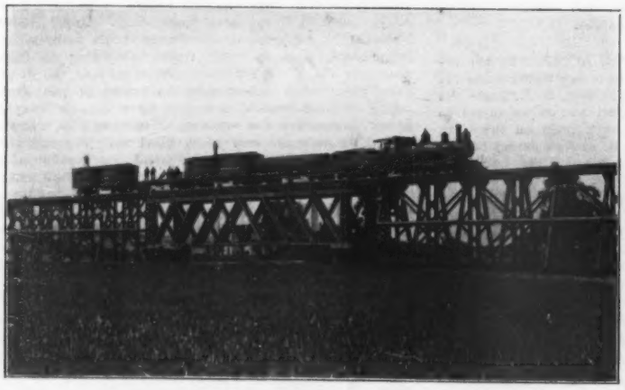


FIG. 1.—BRIDGE & TRESTLE ACROSS DRY CREEK; S. F. & S. J. V. RY.

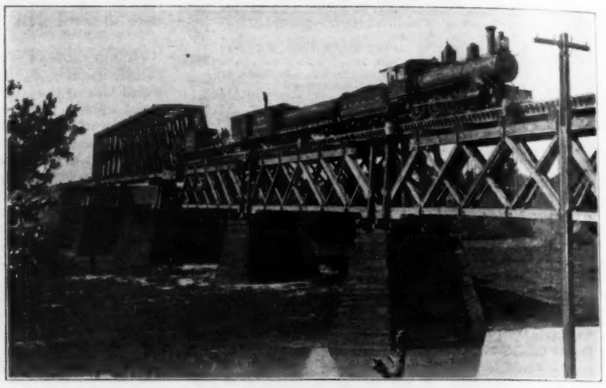


FIG. 2.—BRIDGE ACROSS STANISLAUS RIVER; S. F. & S. J. V. RY.

MODERN OVERHEAD CONSTRUCTION FOR ELECTRIC RAILWAYS.*

By Benjamin Willard.

The steel pole presents a neat appearance, and takes up a small amount of space. The insulating qualities are not as good as with the wood pole. As to its lasting qualities, I have made some observations on wrought iron columns that have been in the ground for several years, and I am convinced that in a moist climate a limit on the practical life of such poles would not be over 30 years. I believe that from a practical and financial standpoint, wood poles should be used in many instances.

Through the business sections of cities steel poles are in some respects better, as they cannot be either willfully or accidentally mutilated. In suburban or residential districts the wood poles when properly dimensioned answer every purpose, and look fully as well as the steel poles. A heart pine or cedar pole will, if properly selected and kept painted, last in some climates 20 years. This is a known fact from observation of poles that are now in sound condition after having been erected for that length of time.

Suppose we select New Orleans as a suitable location to build a road and base our estimates on cost of material there. The cost of steel poles would be greater than in many northern cities owing to freight rates and distance from the manufacturers of such poles. Wood poles can be furnished for less in New Orleans owing to their near production, so that I think an estimate covering the cost at that point would be a fitting proposition elsewhere.

The following are estimates for cost of construction in New Orleans, where steel poles cost more and wooden poles less than in Northern cities. For one mile of span wire construction 104 steel poles, at $15 each, would cost $1,560, and assuming their life to be 30 years, the interest on the investment for 30 years at 5% per annum would be $2,340, or a total first cost and interest of $3,900. The setting of steel poles necessitates the use of concrete. I estimate the cost of this and the labor of placing it at $4.50 per pole, or $468 per mile, which, with interest for 30 years at 5% per annum, would be $1,170, or a total for interest and first cost of material and labor of $5,070 for the steel poles.

Assuming the life of heart pine poles to be 12 years (instead of 20 years) I will make a comparison on that basis. Such poles for one mile of span wire construction at 104 poles to the mile at $4.50 each would cost $468; labor and material for erecting at $2.50 per pole, $260, or a total first cost of $728; to this must be added interest for 30 years at 5% per annum, $1,092, making the first investment at the end of 30 years $1,820. At the expiration of 12 years the construction must be renewed at a cost of $728, and to this must be added interest for 18 years at 5% per annum, $655.20, making the second investment at the end of 30 years cost $1,383.20.

At the expiration of 24 years the construction will be renewed for the third time at a cost of $728, and to this will be added the interest for six years at 5% per annum, $218.40, making the third investment at the end of 30 years cost $946.40, a grand total for wood pole construction of $4,149.60. The difference between the total costs of steel and wood pole construction for a period of 30 years would be $920.40 per mile, which would be more than a liberal allowance for changing span wires and other work necessary in renewing the wood poles, but assuming it would take this amount we would stand even at the end of 30 years and still have six years more life in the wood pole construction.

If steel span poles are used I would recommend for the average span of 40 ft. a pole weighing about 700 lbs., made in two parts. The lower section to be constructed of 6-in. extra heavy standard steel pipe and the upper section of 5-in., swaged at the joint for a distance of 18 ins. Such a pole should be 28 ft. long, 18 ft. for the lower and 10 ft. for the upper section, and provided with a cast-iron and wood pole top for the attachment of the span wires. There should be a wood filling to fit the bottom of the lower half to prevent it from sinking, and the pole should be set 6 ft. in the ground with a rake of 10 ins. from the perpendicular to allow for being straightened when under strain. The average size of hole to be dug would be 20 ins. in diameter with a depth of a little over 6 ft., requiring (after the pole is inserted) a

*Abstract of a paper read at the Annual Convention of the American Street Railway Association at St. Louis.

mixture of about ½ cu. yd. of 1, 2 and 4 Portland cement concrete. The cement should be set at least three days before attaching the span wires. Whenever it is practicable, allow poles to bear against the curbing, as it affords an efficient stay for the pole. Otherwise a good-sized rock having a bearing surface of about 1 sq. ft. would assist very much, and keep the pressure from cracking the cement.

If wood poles are used where it is necessary to provide neat and substantial construction, I would recommend for the average span of 40 ft. a long leaf yellow pine pole dressed and chamfered, 30 ft. long, sawed square, 11 × 11 ins. at the base, and 7 × 7 ins. at the point, free from sap, rot or knots, and corners evenly chamfered, 1½ ins., beginning at a point 14 ft. from the base, and terminating in an octagonal form and roofed evenly for a space of 3 ins.

In setting wood poles where concrete is not used (and I do not consider it necessary) a great deal depends upon the soil encountered. In a soil of medium clay, and average condition, poles should be set 6 ft. in the ground with a rake of 12 ins. from the perpendicular, and the hole should be dug to a vertical depth of 6 ft. (or more if necessary to allow the pole to stand a given height above the track) and should be about 2 ft. square at the top and not less than 18 ins. at the bottom. Where it is practicable allow poles to bear against the curbing (or paving). Place a substantial bearing at the heel to prevent the pole from pressing through the earth; for this purpose a small quantity of coarse broken stone or brick bats will answer every purpose. Where this is not easily obtainable, and the earth is soft, a piece of plank 12 ins. wide by 3 ins. thick, 4 ft. long, sharpened and driven in the earth to a depth of about 2 ft. at the back and base of the pole will give good results.

Whenever it is necessary to erect poles in the absence of substantial material at the surface, such as paving or curbing, I would recommend that the base of the pole be well rammed with broken rock for a distance of 18 ins., taking pains that the greater quantity is placed at the back where the pressure is greatest and leaving a small quantity in front where no pressure takes place. The space to within 20 ins. of the top may be filled with earth taken from the hole and well rammed. To prevent the pole from yielding at the surface a breast plank of oak (or cypress) timber 3 × 12 ins. × 6 ft. should be placed and spiked in front and at right angles to the pole about 8 ins. under the surface of the ground. About 20 ins. from the top of the hole and in front of the breast plank should be filled and well rammed with the same material that is used at the base of the pole. The necessary quantity of broken rock required would be about 1-5 cu. yd. per pole.

Poles of wood or steel which may be used for holding strains at curves should necessarily be heavier than those used for straight line construction, and should also be set at greater depth in the ground. A steel pole for curve construction should be 29 ft. long, made of 6-in. and 7-in. extra heavy pipe, the larger section to be 19 ft. long and the smaller section to be 10 ft. long and made to weigh 1,050 lbs. Such poles should be set 7 ft. in the ground, and raked 10 ins. from the perpendicular in a direction radiating from central point of curve where strain is required. The filling would be the same as specified for straight line iron pole construction.

Wood poles for curve construction would be made similar to those specified heretofore for straight line construction, excepting dimensions of such poles should be 31 ft. long by 14 × 14 ins. at the butt, 9 × 9 ins. at the top. Such poles should be set 7 ft. in the ground and raked 12 ins. from the perpendicular in a direction radiating from the center of curvature where strain is required. The hole should then be entirely filled with about 7-10 cu. yd. of broken rock well rammed.

The holes for eye-bolts should be bored in wood poles before their erection and the bolt should incline slightly downward towards the eye to prevent the water from following in and rotting the top of the pole. The correct location for eyebolt holes would be determined by the height at which the trolley wire is to be placed, 22 ft. from the base of the pole would be correct, assuming that we allow 2 ft. for drop in the earbody and ear, and also dip in the span wire would make the height of trolley wire about 20 ft. To facilitate the setting of poles to a uniform height it is a good plan to place grade stakes near the location selected for poles indicating a given height relative to the grade of the track.

Center pole constuction is required in many locations, but I consider span construction better owing to its flexibility and for being less unsightly. There are now on the market appliances for making bracket suspensions flexible, which are an improvement over the old type of rigid construction. One of the most practical which I am familiar with is an attachment to receive a short span of flexible wire and the ordinary straight line hangers.

Poles used for center and bracket construction should be made according to the same specifications as those used for span construction, excepting that an ornamental pole top would be required for the steel pole instead of an insulated one. For the bracket arm a 1½-in. pipe of the required length attached to a malleable iron collar made in halves and encircling the pole and supported by truss rods leading from the end and center of the arm to near the top makes an excellent and neat construction.

Wherever guard wires are required it will be necessary to leave about 2 ft. additional space on the top of the pole above where the trolley span wires are attached for the attachment of the guard wire span. It would hardly be practical to provide an insulated pole top for both span wires, so the trolley span would be supported by means of a wrought iron clamp collar encircling the pole at the proper point and provided with suitable insulating fastenings. I do not especially approve of this method of construction (as I do not favor guard wires), but I would recommend it where it is compulsory to erect guard wires.

All poles should be painted with one coat before their erection, as it affords better opportunities to carefully apply the priming coat and at less expense than after the poles are set. A paint of dark green composed of graphite mixture I find to wear well, and although it costs more than some other paints, it has better lasting qualities (especially in iron work). A second coat of this paint after the poles are erected will cover marred places made necessary in setting, and will look well and last for at least two years.

Span Wires.—Span wires should be of flexible steel, 5-16 in. in diameter, composed of seven strands of No. 12 galvanized wire, and when under strain with conditions of pole setting as above would have a tension of about 750 lbs. when erected. Whereas I have allowed 18 ins. for sag in the span, it probably would not be over 12 ins. at the time the wire is first suspended, but it will gradually sag more as the wire stretches and the poles spring or yield in the ground, so if a 40-ft. span is attached 22 ft. above the rail surface, the trolley wire within the course of a year would measure aproximately 20 ft. above the rail.

Where wood poles are used (or wood pole tops for steel poles) the ordinary ⅝ × 12-in eye-bolt, threaded about 4 ins., answers every purpose for the attachment of the span wires, and other devices more expensive which are used for the same purpose are not necessary. Poles when properly set will bear a given strain on the span wires for many years without much yielding, consequently an adjustable device is rarely, if ever, used. Hard drawn copper trolley wire of No. 0 B. & S. gage has been found to be the most practical dimension of wire and is generally considered a standard for most trolley construction; therefore, overhead appliances are made of various manufacture to meet such requirements. There has been a trolley wire recently manufactured of a figure 8 section which is now in use on some roads and has given very good results. Where this wire is used it leaves a perfectly unobstructed surface for the trolley wheel and gives greater current carrying capacity, but in modern construction the hanging appliances have reached such a degree of perfection that the round wire can be used with equally as good results, and as the trolley wires on large systems are relied upon but little as a conductor for current capacity, I can hardly recommend anything that would be more practical than the round wire.

The best forms of span wire hangers and insulators are those in which the insulation is concealed from the weather as much as possible, and with a metallic covering to prevent them from being broken by accidental contact of the trolley pole. Brass hangers are more expensive than iron, but resist the moisture and are maintained at much less expense. Iron hangers if kept in good condition should be painted at least once a year, as the oxidization if allowed to accumulate will form a conductor between the conductors and span wires, and in course of time will cause the escape of current by leakage. Hard rubber insulation for hangers is more expensive than many other compositions, but it has fine insulating qualities, and stands different conditions of climate with little or no deterioration.

Suspension ears are of as many varieties as hangers. I have had experience with many, and have concluded that a little modification of the old brass solder ear is the most practical and lasting of all, if properly attached. A solder ear should be 15 ins. in length tapped for a ⅝-in. cap bolt and provided with thin lips at either end so dimensioned as to encircle but little more than half the trolley wire. One point which should be observed very particularly is to have the ends of the ears ground to a thin tapering end so that they will be flexible with the vibrations of the wire. If the ends are made heavy or unyielding, the vibrations will have a tendency to detach the ear at the points, and when this takes place it is a question of a short time before the ear is wholly detached.

For curve construction I favor what is known as the goose-neck hanger, which is simply a ⅝-in. steel forging of such dimensions as to allow good clearance for the trolley wheel and fastened to the soldered ear in a manner to permit it to swivel, also provided with an eye for the attachment of pull-over wires. Such devices are strong, and do not present an obstructive object for the trolley to catch in. There is no insulation attached to such ears and this is the only thing in their disfavor, but as there are many insulating devices to overcome this difficulty which can be attached to the hanger, this could be considered a minor point.

There is a wide difference of opinion relative to the arrangement of sections and the methods of feeding the sections of the trolley wire. In many installations a practice is made of leading each individual section feeder to the station and separating the trolley into sections by sectional insulations, making it possible to cut out the various sections at the power-house. This is a convenience in that it makes every section of the line directly controllable from the power plant. Another method is to have every feeder on the whole line doing a share of work at all times, whether the cars be assembled on one section or distributed over the entire line. This, of course, can only be done by means of connections representing the whole line as being in one general section, making short sections controllable by external switches. In the first method mentioned an accumulation of cars may be assembled on one section not estimated for carrying an abnormal load, consequently the feeder would be overtaxed on this particular section, whereas the feeders on other sections would be doing little or no work. Consequently, there would be a difference of potential between the adjoining sections. If there is a bridge around each section insulator connecting each section together and connected by a feed wire so that the current will equalize itself between two sections and will distribute itself from all feeders, then we have a small amount of variation of potential from section to section, and every feeder is auxiliary to every other.

To carry out this method of uniting the trolley sections the line is divided into sections by means of sectional insulators. A switch box is placed on the pole (at a convenient height) in which is contained two switches and fuses, one for the section on either side of the sectional insulator; the feeder is then divided by connection through each switch so that the feed wire delivers current to either section through feeder span wires attached to connections on each side of the sectional insulator. When the entire line is in operation there is an equalization of current in all sections, and the trolley remains virtually as a solid conductor, but with all necessary features for disconnecting the sections.

In most localities where a large system of feed wire distribution is required it is necessary to erect special construction for that purpose. The most economical plan is to select centers of distribution reached by the most direct routes from the power station and establish at such points what may be called junction poles to which are attached the heavy trunk line feeders leading from the power plant, and smaller feeders for distribution to the trolley line. By this plan we may erect wires of 500,000 or more circular mils. capacity from the plant to the junction pole, and attach them to a junction frame or frames attached to the pole which is provided with a bus-bar of sufficient carrying capacity to carry the current of the branch feeders. The large cables are dead-ended in the junction frame by eye-bolts and strain insulators, and copper connections are made with the bus-bar. The branch feeders are ended and connected in the same way so that it is possible with little delay to cut out any feeder and make changes which are often necessary in operation.

Southern pine cross arms, 5 × 3½-ins., bored to receive 1½-in. pins and doubled on each pole will make sufficiently strong construction to receive the heaviest wires. The pins should be of locust-wood, bored to receive a ½-in. bolt, which should extend vertically through the center of the pin and terminate with a washer and nut on the under side of the arm.

Top grooved glass insulators are desirable in all classes of heavy feed wire construction. Feed wire conductors of larger area than 0000 B. & S. gage should be in stranded, or in cable form, triple insulated with the best waterproof covering. Care should be taken in splicing cables that an even strain is brought on each smaller wire and that none are allowed to remain without good contact, and that all flux used in soldering is carefully removed before tapeing.

THE STONE INDUSTRY OF THE UNITED STATES IN 1894 AND 1895.

The Department of the Interior has issued a report upon "The Stone Industry in 1895," prepared by Mr. William C. Day, of the U. S. Geological Survey. From it the following extracts are made: The values of the several kinds of stone produced in the two years are set down as follows:

Kind.	1894.	1895.
Granite	$10,029,156	$8,804,328
Marble	3,190,585	2,825,719
Slate	2,790,324	2,698,700
Sandstone	3,945,847	4,211,314
Limestone	16,190,118	15,308,755
Bluestone	900,000	750,000
Totals	$37,055,030	$34,688,816

Divided by states, Pennsylvania ranks first with a product, chiefly limestone, worth $5,563,451; Vermont marble and granite was worth $3,254,647 in almost equal amounts; Ohio limestone and sandstone was valued at $3,018,372; Maine's product was worth $2,240,154, mainly granite, and Massachusetts produced $2,335,381 worth of stone, almost all granite. After these states come New York, Indiana, Illinois, Connecticut, Georgia and Missouri, in the order named, with products val-

ued at more than $1,000,000 and less than $2,000,000; although 39 states in all contribute something to this industry. The total value of granite paving blocks made in 1895 was $1,773,328; Maine and Massachusetts contributing $1,132,607 of this amount. In 1894 the value of paving blocks produced was $2,254,587. The granite output of the United States shows a steady decline from $14,464,095 in 1890, to $8,894,328 in 1895; with the exception of the gain noted for 1894 over the $8,808,934 of 1893. The marble product shows a gain from 1890 to 1893, a maximum in 1894 and a decline in 1895. The total of roofing slate for 1895 was 729,927 squares valued at $2,351,509, as compared with 738,222 squares valued, in 1894, at $2,301,138; the price, however, has increased from $3.11 to $3.23 in 1895. The sandstone industry shows a slight improvement in general condition; though the value of this product in 1890 was $10,816,057. The value of the lime output, in 1895, was $6,595,122 as compared with $8,610,607 for the preceding year, a falling-off nearly sufficient in itself to account for the total decrease in the value of the industry as compared with 1894. But the decrease in lime burned was offset by an increase of more than half a million in the limestone used for fluxing in 1895 in Alabama, Colorado, Montana, Ohio and Pennsylvania. The bluestone output is estimated for both 1894 and 1895, and the report enters into no details of this industry.

SPIRAL CURVES FOR STREET RAILWAYS.*

By Chas. A. Alden, C. E.**

The use of the railway spiral as an entrance to street railway curves, has not been as extended as it should have been, owing to the lack of suitable tables for its use.

While many variations of its form might be made, it is believed that the following tables will meet most cases arising in usual practice.

Table I. gives a choice of 50 spirals for curves of radii from 30 ft. to 1,785 ft. In case a special spiral is desired for any reason, these may be modified by multiplying by a suitable factor, in the same way that spirals No. 1 and No. 2 have been obtained from spirals No. 4 and No. 5.

Spiral No. 3 was designed as the spiral of shortest length to enable a certain double-truck car to pass on a double-track curve. Branch-off Easement No. 2 was designed in the same manner.

While the car used for this purpose was one of the largest double-truck cars in use, on surface roads, in the East; this should be carefully tried with the car in use on the road in question, as, indeed, it must necessarily be, in order to select a radius for the outer curve.

Substantially the same chord length was carried throughout the system with a view to ease in giving the necessary information to the tracklayers.

At switches it is mechanically undesirable to have a greater initial radius than 100 ft. This will prevent the use of a true spiral at these points, but Table II. gives a set of arbitrary easements which conform as nearly as possible to the theory of the spiral; i. e., they have a constant increase or decrease of angle in each length of arc after leaving the switch.

Office Work.—The most satisfactory way of plotting these curves is to cut out thin celluloid templates of each one which is to be used. Mark each P. C. C. of the spiral on the curved edge and the direction of a radial line through this point.

Problems No. 3 and No. 4 can generally be solved accurately enough on a drawing made to scale and in less time than by calculation for "special work" curves, as a plan must be made in any event, in order to have the work made by the manufacturer.

If only a few curves are to be drawn up, however it may be more expeditious to figure the curve and plot the points on the spiral by the x and y taken from the table, and connect them with a variable or "French" curve.

Field Work.—The problems which are solved below give all the rules necessary for laying out nearly any curve with symmetrical spirals. In the appendix is given the solution for the most common form of non-symmetrical curve.

It is by no means necessary to lay out on the ground every point on the spiral. If the curve is "special work" and curved by the manufacturer, the point of spiral, a point about in the centre of the spiral and the junction of the spiral with the main curve should be laid out.

Points for the latter should be laid out from 20 to 30 ft. apart, depending on the radius of the curve and the location of the joints.

If the curve is to be "sprung in" by the tracklayers, every alternate point on the spiral should be laid out and the track-layer furnished with sufficient middle ordinates for 10-ft. chords.

These can be obtained by Problems 9 and 10 and Table III.

The most expeditious way to lay out a spiral curve, if the "x" does not exceed 2 ft., is to set the transit on the intersection point and lay off the tangent distances, then lay out sufficient points on the spirals by the successive offsets x and the long chords. Then bisect the included angle and lay out a temporary point v; Problem 8.

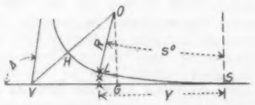
Move the transit to the last point on the spiral, set the vernier to a back reading equal to the spiral angle. Set the telescope on an offset from v equal to x inside of the intersection point. Deflect to 0° and the line of the telescope should strike v' and the distance v' L = R tan (½ ▽ — s°). This will check the preceding calculations and field work. The circular arc can then be laid out in the usual manner.

Problem No. 1.—To Select a Spiral.—(a). The radius of the main curve must be less than the preceding branch of the spiral; must be more than the next branch would be, were it produced; and should nearly equal the latter.

Note.—Easements No. 3 and No. 4, Table II. For greater, read less; and for less, read greater.

(b). The longer the spiral, the easier the entrance will be. But bear in mind that the main body of the curve should be circular, the spiral simply acting as an entrance to it.

(c). A spiral of less than three branches should not be used.



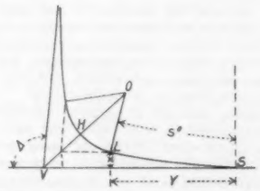
Problem No. 2.—Given: A circular curve with symmetrical spirals, to find the tangent and external distances.

O G = R + x — ver. sine s° R.

G S = y — sine s° R.

Tangent distance = O G tan ½ △ + G S.

External distance = O G ex. sec. ½ △ + x — ver. sine s° R.



Problem No. 3.—Given: The tangent distance vs. the intersection angle △, and the desired length of spiral to find the radius of the curve.—Approximate R = cotangent ½ △ (vs. — ½ length of spiral.)

Having selected a spiral by this radius, the exact radius may be found, if required, by the following formula:

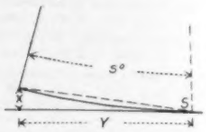
$$R = \frac{\cos. \frac{1}{2} \triangle \ (v\ s - y - x \tan \frac{1}{2} \triangle)}{\text{sine } (\frac{1}{2} \triangle - 5)}$$

Caution: If the result is enough different from the original radius to require a change in the spiral by Problem No. 1 (a), a second trial must be made. This rule does not apply for approximate radius to the easements in Table II.

Problem No. 4.—Given: The intersection angle △ and the external distance VH; to find the radius.—Approximate to the radius by finding that for a simple curve passing through the point H, and select a spiral for a radius somewhat smaller. Then

$$R = \frac{V\,H \cos. \frac{1}{2} \triangle - x.}{\cos. s° - \cos. \frac{1}{2} \triangle.} \text{ (Searle.)}$$

Caution: If the result is enough different from the original radius to require a change in the spiral by Problem No. 1 (a), a second trial must be made.



Problem No. 5.—Given: The x and y for any point on the spiral; to find the deflection from the tangent at the point of spiral.

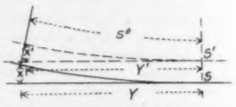
$$\text{Tan. deflection } ° = \frac{x}{y}.$$

Problem No. 6.—Given: The x and y for any point on the spiral; to find the long chord.

(a). Long chord = $\frac{y}{\text{cosine def. angle}}$.

or

(b). Long chord = $\sqrt{x^2 + y^2}$.

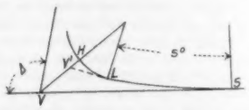


Problem No. 7.—Given: x and y for a point on the spiral; to find x' and y' on a line paralel to the spiral, and offsetted the distance ss' inside the spiral.

x' = x — s s' ver. sine s°.

y' = y — s s' sine s°.

Note.—Problems Nos. 5 and 6 can then be applied to x' and y' if it is desired to use deflection angles to lay out the curve. As these curves will almost invariably be laid out on an offset, varying with the gage of the road; the deflections are not figured in the table.



Problem No. 8.—Given: A circular curve with spirals; to find the distance VV', in order to lay out a tangent to the circular curve, from which the latter may be laid out in the usual manner.—

V H = see Problem No. 2.

V' = R ex. secant (½ △ — s).

V V' = V H — V' H.

Problem No. 9.—Given: The middle ordinate for a chord of length AB for R and R'; to find the middle ordinate at the P. C. C. From the figure it is evident that

$$D'\,C' \text{ bisects } C\,D \therefore E\,F = \frac{C\,F + D\,F}{2}.$$

Therefore, the middle ordinate at any P. C. C. in the spiral equals ½ the sum of the middle ordinates for the radii on each side for the same chord.

Note.—See remark following Problem No. 10.

Problem No. 10.—Given: That portion of a spiral with equal chords L, L' and L" and angles a—b,

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a and a+b; to find the middle ordinate at the centre of the chord L in the length D'C'; CF = C' A and DF = D'B. From the figure it is evident that D' C' bisects C D, $\therefore$ E F $= \frac{C F + D F}{2}$.

Then

$$C' A = \tfrac{1}{2} L \tan \tfrac{1}{4} a + L' \sin e \left(\tfrac{1}{2} a + \frac{a+b}{2} \cdot \right)$$

$$D' B = \tfrac{1}{2} L \tan \tfrac{1}{4} a + L'' \sin e \left(\tfrac{1}{2} a + \frac{a-b}{2} \cdot \right)$$

and since the sines of small angles are proportional to the angles;

$$\frac{C F + D F}{2} = E F = \tfrac{1}{2} L \tan \tfrac{1}{4} a + L \sin e a.$$

But this last equation equals the middle ordinate in the length AB for the radius of the central arc; and since the increment to the angle, b, would be equal if L' and L'' were equal; the middle ordinate at the centre of any arc of the spiral, for any length of chord; is equal to the middle ordinate of the radius of that arc in the same length.

Remark: It will be noticed that the solutions of Problems No. 9 and No. 10 are slightly inaccurate in not allowing for the increase of length of D'C' over AB, nor for the inclination of the middle ordinate found to the true middle ordinate.

Problem No. 10, if applied to the curving of rails, as intended, also assumes that each rail forms a spiral, whereas they are simply parallel lines to one.

Both solutions, however, are sufficiently accurate for any spiral of 5 ft. chords or greater.

Taken in connection with Table III. the m. o's can be easily found for points on the rails from 2½ ft. to 3 ft. apart. The rails being curved to these, exactly what is desired will be obtained, i. e., a curve of constantly changing radius, which is considered a compound curve for the purpose of calculation only.

These spirals are figured for a length suitable to the ordinary street railway speeds. For greater speeds, the writer would advise the use of the regular railway spirals. Tables in convenient form for these have been published by Wm. H. Searle, C. E., and others.

The tables given herewith have been carefully checked, and no error found as great as 1 in the last place.

TABLE I.—Spirals.

Spiral No. 1.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
210	0° 42′	0.015	2.565	0° 42′	.00007	.01222
105	1° 24′	0.078	5.130	2° 6′	.00067	.03664
70	2° 6′	0.219	7.692	4° 12′	.00269	.07324
52½	2° 48′	0.469	10.245	7° 00′	.00745	.12187
42	3° 30′	0.860	12.780	10° 30′	.01675	.18224
35	4° 12′	1.420	15.283	14° 42′	.03273	.25376

Spiral No. 2.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
300	0° 30′	0.011	2.618	0° 30′	.00004	.00873
150	1° 00′	0.057	5.235	1° 30′	.00034	.02618
100	1° 30′	0.100	7.851	3° 00′	.00137	.05234
75	2° 00′	0.342	10.463	5° 00′	.00381	.08716
60	2° 30′	0.627	13.065	7° 30′	.00856	.13053
50	3° 00′	1.036	15.651	10° 30′	.01675	.18224
42½	3° 30′	1.587	18.187	14° 00′	.02970	.24192
37½	4° 00′	2.309	20.703	18° 00′	.04894	.30902

Spiral No. 3.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
300	1° 00′	0.046	5.236	1° 00′	.00015	.01745
150	2° 00′	0.229	10.468	3° 00′	.00137	.05234
100	3° 00′	0.639	15.688	6° 00′	.00548	.10453
75	4° 00′	1.368	20.871	10° 00′	.01519	.17365
60	5° 00′	2.501	25.982	15° 00′	.03407	.25882
50	6° 00′	4.118	30.959	21° 00′	.06642	.35837
40	7° 00′	6.143	35.403	28° 00′	.11705	.46947

Spiral No. 4.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
420	0° 42′	0.031	5.131	0° 42′	.00007	.01222
210	1° 24′	0.157	10.261	2° 6′	.00067	.03664
140	2° 6′	0.439	15.384	4° 12′	.00269	.07324
105	2° 48′	0.939	20.490	7° 00′	.00745	.12187
84	3° 30′	1.720	25.561	10° 30′	.01675	.18224
70	4° 12′	2.839	30.567	14° 42′	.03273	.25376
60	4° 54′	4.352	35.469	19° 36′	.05794	.33545

Spiral No. 5.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
600	0° 30′	0.023	5.236	0° 30′	.00004	.00873
300	1° 00′	0.114	10.471	1° 30′	.00034	.02618
200	1° 30′	0.320	15.703	3° 00′	.00137	.05234
150	2° 00′	0.685	20.926	5° 00′	.00381	.08716
120	2° 30′	1.255	26.130	7° 30′	.00856	.13053
100	3° 00′	2.073	31.302	10° 30′	.01675	.18224
85	3° 30′	3.175	36.374	14° 00′	.02970	.24192

Spiral No. 6.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
900	0° 20′	0.015	5.236	0° 20′	.00002	.00582
450	0° 40′	0.076	10.472	1° 00′	.00015	.01745
300	1° 00′	0.213	15.706	2° 00′	.00061	.03490
225	1° 20′	0.457	20.936	3° 20′	.00169	.05814
180	1° 40′	0.837	26.158	5° 00′	.00381	.08716
150	2° 00′	1.385	31.365	7° 00′	.00745	.12187
128	2° 20′	2.125	36.524	9° 20′	.01324	.16218

Spiral No. 7.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
1,260	0° 15′	0.012	5.498	0° 15′	.00001	.00436
630	0° 30′	0.060	10.995	0° 45′	.00009	.01309
420	0° 45′	0.168	16.492	1° 30′	.00034	.02618
315	1° 00′	0.360	21.987	2° 30′	.00095	.04362
252	1° 15′	0.660	27.475	3° 45′	.00214	.06540
210	1° 30′	1.091	32.597	5° 15′	.00420	.09150
180	1° 45′	1.678	38.424	7° 00′	.00745	.12187

Spiral No. 8.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
1,890	0° 10′	0.008	5.498	0° 10′	.00000	.00291
945	0° 20′	0.040	10.996	0° 30′	.00004	.00873
630	0° 30′	0.112	16.493	1° 00′	.00015	.01745
472½	0° 40′	0.241	21.990	1° 40′	.00042	.02908
378	0° 50′	0.441	27.483	2° 30′	.00095	.04362
315	1° 00′	0.729	32.973	3° 30′	.00187	.06105
270	1° 10′	1.120	38.457	4° 40′	.00332	.08136

Spiral No. 9.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
2,730	0° 7′	0.006	5.550	0° 7′	.00000	.00204
1,365	0° 14′	0.028	11.118	0° 21′	.00002	.00611
910	0° 21′	0.079	16.677	0° 42′	.00007	.01222
682½	0° 28′	0.170	22.234	1° 10′	.00021	.02036
546	0° 35′	0.311	27.791	1° 45′	.00047	.03054
455	0° 42′	0.515	33.346	2° 27′	.00091	.04275
390	0° 49′	0.792	38.899	3° 16′	.00162	.05698

Spiral No. 10.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
3,780	0° 5′	0.004	5.498	0° 5′	.00000	.00145
1,890	0° 10′	0.020	10.996	0° 15′	.00001	.00436
1,260	0° 15′	0.056	16.493	0° 30′	.00004	.00873
945	0° 20′	0.120	21.991	0° 50′	.00011	.01454
756	0° 25′	0.230	27.488	1° 15′	.00024	.02181
630	0° 30′	0.364	32.983	1° 45′	.00047	.03054
540	0° 35′	0.560	38.478	2° 20′	.00083	.04071

Spiral No. 11.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
5,250	0° 4′	0.0035	6.109	0° 4′	.00000	.00116
2,625	0° 8′	0.0178	12.217	0° 12′	.00001	.00349
1,750	0° 12′	0.0498	18.326	0° 24′	.00002	.00698
1,312½	0° 16′	0.1066	24.434	0° 40′	.00007	.01164
1,050	0° 20′	0.1955	30.542	1° 00′	.00015	.01745
875	0° 24′	0.3234	36.649	1° 24′	.00030	.02443
750	0° 28′	0.4975	42.756	1° 52′	.00053	.03257

Spiral No. 12.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
7,140	0° 3′	0.0027	6.231	0° 3′	.00000	.00087
3,570	0° 6′	0.0136	12.462	0° 9′	.00000	.00262
2,380	0° 9′	0.0381	18.692	0° 18′	.00001	.00524
1,785	0° 12′	0.0816	24.923	0° 30′	.00004	.00873
1,428	0° 15′	0.1495	31.153	0° 45′	.00009	.01308
1,190	0° 18′	0.2474	37.384	1° 3′	.00017	.01832
1,020	0° 21′	0.3806	43.613	1° 24′	.00030	.02443

TABLE II.—Branch-off Easements.

Easement No. 1.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
75	7° 50′	0.700	10.222	7° 50′	.00033	.13629
70	2° 30′	1.182	13.238	10° 20′	.01622	.17937
52½	3° 20′	1.816	16.225	13° 40′	.02831	.23627
42	4° 10′	2.646	19.164	17° 50′	.04805	.30625
35	5° 00′	3.707	22.027	22° 50′	.07836	.38805

Easement No. 2.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
102½	6° 30′	0.658	11.584	6° 30′	.00643	.11320
83½	3° 30′	1.388	16.621	10° 00′	.01519	.17365
62½	4° 40′	2.475	21.593	14° 40′	.03258	.25720
50	5° 50′	4.011	26.444	20° 30′	.06333	.35021
40	7° 00′	5.998	30.906	27° 30′	.11299	.46175

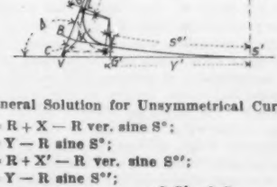
Easement No. 3.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
75	7° 50′	0.700	10.222	7° 50′	.00933	.13629
85	2° 55′	1.399	14.492	10° 45′	.01755	.18652
100	2° 30′	2.306	18.759	13° 15′	.02862	.22920
120	2° 5′	3.383	22.987	15° 20′	.03560	.26443
150	1° 40′	4.598	27.178	17° 00′	.04370	.29237
200	1° 15′	5.919	31.336	18° 15′	.05030	.31316
300	0° 50′	7.315	35.470	19° 5′	.05496	.32694
600	0° 25′	8.757	39.588	19° 30′	.05736	.33381

Easement No. 4.

Radius.	Angle.	x	y	s°	ver. sine.	sine.
102½	6° 30′	0.658	11.584	6° 30′	.00643	.11320
120	2° 00′	1.204	15.737	8° 30′	.01098	.14781
144	1° 40′	1.884	19.870	10° 10′	.01570	.17651
180	1° 20′	2.671	23.984	11° 30′	.02008	.19937
240	1° 00′	3.542	28.082	12° 30′	.02370	.21644
360	0° 40′	4.473	32.166	13° 10′	.02629	.22778
720	0° 20′	5.439	36.242	13° 30′	.02763	.23345

APPENDIX.



General Solution for Unsymmetrical Curves.

O G = R + X − R ver. sine S°;

G S = Y − R sine S°;

O G′ = R + X′ − R ver. sine S°′;

G′ S′ = Y − R sine S°′;

$$V S = \text{Tan } \tfrac{1}{2} \triangle O G + G S + \frac{O G' - O G}{\text{sine } \triangle};$$

$$V S' = \text{Tan } \tfrac{1}{2} \triangle O G + G' S' \pm \frac{O G' - O G}{\text{Tan } \wedge}$$

Note—± in above; + if △ = 90° + and − if △ = 90° −,

△′ = ∧ − (S° + S°′);

V′ L or V′ L′ = Tan ½ △′ R;

V′ B = X + V L sine° S;

V B = V S − (Y + V L − V L ver. sine S°);

TABLE III.

MIDDLE ORDINATES, 10 FT. CHORDS.

M. O. in.	RADIUS. ft.	in.	M. O. in.	RADIUS. ft.	in.	M. O. in.	RADIUS. ft.	in.
0	infinity.		1	150	0¼	2	75	1
1/16	4807	8	1 1/16	145	6	2 1/16	73	11 7/16
1/8	2390	3	1 1/8	141	2½	2 1/8	72	9½
3/16	1600	6	1 3/16	137	3/8	2 3/16	71	8¼
¼	1200	9	1¼	133	4½	2¼	70	8¼
5/16	960	1	1 5/16	129	9 5/16	2 5/16	69	7¼
3/8	800	3 1/16	1 3/8	126	4½	2 3/8	68	7 1/16
7/16	682	3 1/16	1 7/16	1 3	2½	2 7/16	67	8½
½	600	0½	1½	120	0½	2½	66	9½
9/16	533	4½	1 9/16	117	1½	2 9/16	65	10 5/16
5/8	480	0 5/16	1 5/8	114	4½	2 5/8	64	11 5/16
11/16	436	4 5/16	1 11/16	111	8 5/16	2 11/16	64	1 5/16
⅝	400	0 5/16	1⅝	109	1½	2⅝	63	3 5/16
13/16	369	3	1 13/16	106	8 1/16	2 13/16	62	5½
7/8	342	10 5/16	1 7/8	104	4 1/16	2 7/8	61	7 1/16
15/16	320	0½	1 15/16	102	2½	2 15/16	60	10 5/16
1	300	0½	1 1	100	0½	2 1	60	1½
1 1/16	282	4 5/16	1 1/16	98	0½	2 1/16	59	4½
1⅛	266	8 1/16	1⅛	96	0½	2⅛	58	7½
1 3/16	253	0 1/16	1 3/16	94	3 1/16	2 3/16	57	11 1/16
1¼	240	0 5/16	1¼	92	4½	2¼	57	3
1 5/16	228	7 1/16	1 5/16	90	7 1/16	2 5/16	56	7
1⅜	218	1 1/16	1 3/8	88	11½	2 3/8	55	11¼
1 7/16	209	1 1/16	1 7/16	87	4½	2 7/16	55	3 1/16
1½	200	2 5/16	1½	85	9 1/16	2½	54	7 1/16
1 9/16	192	0½	1 9/16	84	3 1/16	2 9/16	54	0 5/16
1⅝	184	7½	1 1/16	82	10	2 1/16	53	5 5/16
1 11/16	177	9 1/16	1 11/16	81	5½	2 11/16	52	10½
1¾	171	5½	1¾	80	0 1/16	2¾	52	3½
1 13/16	165	6½	1 13/16	78	9½	2 13/16	51	8 1/16
1⅞	160	0½	1 1/8	77	6	2 1/8	51	2½
1 15/16	154	10½	1 15/16	76	3½	2 15/16	50	7 1/16

TABLE III. (Continued.)

MIDDLE ORDINATES, 10 FT. CHORDS.

M. O. in.	RADIUS. ft.	in.	M. O. in.	RADIUS. ft.	in.	M. O. in.	RADIUS. ft.	in.
3	50	1½	4	37	8	5	30	2½
3 1/16	49	7 5/16	4 1/16	37	4½	5 1/16	30	0½
3 1/8	49	1½	4 1/8	37	1½	5 1/8	29	10 1/16
3 3/16	48	7½	4 3/16	36	9½	5 3/16	29	7½
3¼	48	1 5/16	4¼	36	6 5/16	5¼	29	5½
3 5/16	47	7½	4 5/16	36	3 5/16	5 5/16	29	3½
3⅜	47	2 5/16	4⅜	35	11½	5⅜	29	1 5/16
3 7/16	46	8½	4 7/16	35	8½	5 7/16	28	11½
3½	46	3½	4½	35	5½	5½	28	9½
3 9/16	45	10 5/16	4 9/16	35	2 5/16	5 9/16	28	7½
3⅝	45	5 5/16	4⅝	34	11 5/16	5⅝	28	5½
3 11/16	45	0	4 11/16	34	8 5/16	5 11/16	28	3½
3¾	44	7	4¾	34	5½	5¾	28	1 5/16
3 13/16	44	2½	4 13/16	34	2½	5 13/16	27	11½
3 7/8	43	9½	4 7/8	33	11½	5 7/8	27	9½
3 15/16	43	4½	4 15/16	33	9 1/16	5 15/16	27	7½
3⅞	43	0 5/16	4⅞	33	6½	5⅞	27	6
3 1/16	42	7½	4 1/16	33	3½	5 1/16	27	4 5/16
3 1/8	42	3 5/16	4 1/8	33	0½	5 1/8	27	2½
3 3/16	41	10½	4 3/16	32	10½	5 3/16	27	0 5/16
3¼	41	6½	4¼	32	7½	5¼	26	10½
3 5/16	41	2½	4 5/16	31	4½	5 5/16	26	9 5/16
3⅜	40	10	4⅜	32	2½	5⅜	26	7 5/16
3 7/16	40	5½	4 7/16	31	11½	5 7/16	26	5 5/16
3½	40	1½	4½	31	9 5/16	5½	26	3½
3 9/16	39	9½	4 9/16	31	6½	5 9/16	26	2½
3⅝	39	6 5/16	4⅝	31	4½	5⅝	26	0 5/16
3 11/16	39	2 5/16	4 11/16	31	2 5/16	5 11/16	25	10½
3¾	38	10 5/16	4¾	30	11½	5¾	25	9 5/16
3 13/16	38	3½	4 13/16	30	7	5 13/16	25	7½
3⅞	37	11½	4⅞	30	4½	5⅞	25	4 5/16

$$\text{Tan } C = \frac{V' B}{V B}.$$

$$V V' = \frac{V B}{\text{cosine } C} \text{ if } C = 45° -;$$

$$V V' = \frac{V' B}{\text{sine } C} \text{ if } C = 45° +;$$

THE ACTUAL ACCURACY OF CHEMICAL ANALYSIS.

The degree of accuracy ordinarily obtained in every-day practice in chemical analysis was discussed by Mr. Frederic P. Dewey in a paper read on May 14, 1896, before the Washington Section of the American Chemical Society ("Jour. Am. Chem. Soc.," Sept., 1896; also "Trans. Am. Inst. M. E.," Denver meeting, Sept., 1896). In May, 1881, Mr William Kent presented a paper to the American Institute of Mining Engineers, entitled "Manganese Determinations in Steel," in which he gave 24 determinations of manganese, by ten different chemists, on samples from a plate of steel. These results presented the remarkable range of from 1.14 to 0.303%. In 1886, Capt. A. E. Hunt ("Trans. Am. Inst. M.E.," vol. XV., p. 104), in giving a measure of the accuracy of the colorimetric method, speaks of a variation of 0.2% in steels

containing from 0.15 to 1.5% of Mn. as "sufficiently accurate for all practical work." This degree of accuracy shows a satisfactory advance over the results reported in 1881. In 1883, Mr. G. C. Stone began a series of contributions on "Determinations of Manganese in Spiegel" ("Trans. Am. Inst. M. E.," XI. 323, XII. 295, 514). In his first paper he reported 13 determinations by five chemists, on the same sample, ranging from 15.49 to 13.83, also 26 determinations by ten chemists, on a sample of the same spiegel, ranging from 14.56 to 10.36%, some of the low results being obtained by experimental methods. Of a total of 73 determinations by 19 different chemists, rejecting eleven on account of methods used, or because the chemists were not entirely satisfied with them; there are left 60 determinations by 18 chemists, ranging from 14.47 to 12.60% and averaging 12.60%. Mr. Dewey concludes from a study of Mr. Stone's results that variations of 0.5% in determinations of spiegel of this grade (10 to 15% Mn.), are to be expected, and much wider variations may be found.

In determinations of phosphorus in steel extensive researches have shown that the different chemists using modern methods obtain results which are highly satisfactory. On one sample 36 results obtained by 23 chemists ranged from 0.055 to 0.045%, an extreme variation of only 0.010%. On another sample 38 results ranged from 0.091 to 0.076%, an extreme variation of 0.015%. In determinations of phosphorus in pig iron the results show a wider variation. Mr. F. E. Bachman, in 1882 ("Trans. Am. Inst. M. E."), reported 44 results by 18 chemists, ranging from 0.165 to 0.096%, the extreme variation being 0.069%. Analyses of copper ores show a wide variation, 45 determinations by 17 chemists gave results ranging from 53.34 to 43.92%. On pig copper the results of 17 determinations by seven chemists ranged from 91.07% to 98.17%, but throwing out six of the results which differed widely from the average the remainder range from 94.91 to 94.38, which may be regarded as very good work. Copper mattes determined by electrolysis by eight chemists, gave from 55.17 to 54.50. The total range of 0.67% is regarded as very satisfactory. By the cyanide method six chemists reported results ranging from 54.08 to 50.55%. A plate of copper analyzed by six chemists gave from 98.46 to 97.04% of copper.

In gold and silver assays of copper-material 26 determinations by 20 chemists gave from 164.35 to 148.5 ounces of silver to the ton, and 0.501 to 0.205 ounces of gold to the ton.

A HARBOR OF REFUGE, near the mouth of Delaware Bay, is about to be constructed by the U. S. government. The location was fixed by a board of U. S. Engineers, under the provisions of the River and Harbor Act of 1890, between the Shears Shoal, about three miles off shore from Lewes, Del., and a breakwater to be constructed; the latter about 8,000 ft. long. In order to protect this harbor from ice coming down the Delaware River a row of ten ice-piers will be built across the head of the harbor, about one-half mile above the breakwater. This breakwater will be about two miles from the old Delaware breakwater and almost north of it; constructed of random stone in very large blocks, with a top width of 40 ft., at low-water mark, and a sea-slope of 1 in 3 and a harbor-slope of 1 in 1.35. For 14 ft. above mean low water the blocks will be laid in courses, with a top width of 20 ft. The protected anchorage will include an area of about 800 acres, with a minimum depth of 30 ft. over 552 acres, and a low-water depth of not less than 24 ft. over the remainder. The total estimated cost is about $4,000,000, divided as follows: Breakwater complete, $3,863,373; ten ice-piers, $377,500; engineering and contingencies, $424,127. The board fixing upon the location was made up of Gen. Wm. P. Craighill, now Chief of Engineers; Major C. W. Raymond and Capt., now Major W. H. Bixby, all of the Corps of Engineers, U. S. A.

A SLIDE-RULE SEWER COMPUTER, which is an application of the Kutter formula to a slide-rule for use in obtaining the discharge, diameter or grade of sewers, has been devised by Mr. B. H. Colby, M. Am. Soc. C. E., Sewer Commissioner and Member of the Board of Public Improvements of St. Louis, Mo. All problems relating to egg-shaped as well as circular sewers can be solved by this simple instrument; and the results are guaranteed to be correct according to Kutter's formula. The computer is made of box wood and is 21 ins. long; it is manufactured and sold by the A. S. Aloe Co., of St. Louis.

STREET RAILWAY TRACK AND TRACK JOINTS.*

By M. K. Bowen.**

In considering this subject I have found that the life of a rail was measured by the wearing out of the head, and that less than 12% was worn away before we sold the old rail for scrap; hence the deduction that the point of contact between the wheel and the rail, or the bearing and wearing part of the track, was a most important consideration. The treads of wheels of street railway cars are made conical in order to center the car on the track. If the wheel were not coned, the wheel which once got behind, or an axle which once assumed a position not at right angles with the truck, would be apt to remain in its faulty position during the entire trip, requiring excess of power to haul the car, and abnormal wear of wheel and rail, resulting in sharp-flanged wheels and short life of rail. If the beveled tread is run on a flat-top rail, as in Fig. 1, all the bearing will be at A.

Fig. 2 is a section of a new and old car wheel which shows clearly the manner in which the tread of the wheel will wear if used on a rail with no bevel. The record of car miles of this wheel is not known, but no doubt

Fig. 1.

Fig. 1.—Bearing of Beveled Wheel Tread on Flat Rail Head.

Fig. 2.

Fig. 2.—Character of Wear of Wheel Tread.

Fig. 3.

Fig. 3.—Wear of Rail in Cable Track After Eight Years' Service.

Fig. 4.

Fig. 4.—Wear of Rail After Eleven Years' Service (Wear Due Chiefly to Wagon Traffic).

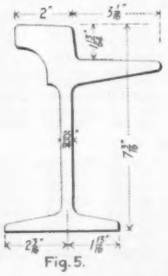


Fig. 5.

Fig. 5.—7-in. Girder Rail for Use with Chairs; Chicago City Ry. Co.

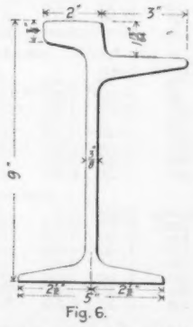


Fig. 6.

Fig. 6.—9-in. Girder Rail for Use Without Chairs; Chicago City Ry.

a great amount of energy was lost before it had worn down to its most economical state. Fig. 3 shows a rail taken from the State St. cable track after 8 years' wear, during which time 8,000,000 car wheels passed over it. Fig. 4 shows a rail taken out after 11 years' wear. The rail should have been taken out three years before, but owing to impossibility of getting rails at the time and the Columbian Exposition coming at that time the track was not rebuilt. The true rate of wear cannot be found, as the flange of the wheel had begun to run on the flange of the rail long before it was taken out. The dotted lines show an interesting state of affairs. This section shows the wear due almost entirely to wagon traffic. Fig. 5 shows the rail used at the present time in our track construction with chairs or tie-plates. The rail weighs 83 lbs. per yd. and has a head 1 3-16 ins. high, beveled as described to conform to the car wheel tread for two-thirds of its section from gage line across the head. Fig. 6 shows the rail used in our electric construction without chairs or tie-plates. The rail weighs [illegible] lbs. per yd., and also has a head 1 3-16 ins. high, beveled as described. The experience of the Chicago City Ry. Co., which first tried this form of head, has been that it saved wear of both rails and wheels, increasing their life by about 35%.

The weakest part of the track construction is in the rail joints. Once weakened they rapidly grow worse, and not only are the rails worn at such joints but the rate of wear of the car equipment is greatly increased. We want some method of keeping the rails from pulling apart at the joints (due to contraction and spreading outward) and from bending down at the joints (due to the pounding and weight of the cars). The joint I have used for the past year is a cast-welded joint. This has been found to give perfect satisfaction as a joint; it is strong and substantial, as has been proved by its holding under the extreme changes in temperature for which Chicago is noted. In 1895 there were 17,000 joints put in on the Chicago City Ry. Co.'s lines, and of these only 154 joints were lost. The joint in comparative tests has been shown to be far stronger than the rail itself, and such breakages as have occurred were due to flaws in the metal. The metal cast around the joint has eight times the cross-sectional area that the rail has. Hence, considering steel as four times as strong as cast-iron, the joint is twice as strong as the rail. It has been found in some cases where this joint was used at crossings with other tracks, the tracks were apt to be pulled out of shape through the changes of temperature. To overcome this the joint nearest the crossing should be anchored in a substantial manner.

The method of making the joint is as follows. The rails at the joint are scraped and brightened, a cast-iron mold is placed around the joint, making a tight fit, and into this is poured the molten iron, 25% scrap, 25% soft and 50% hard silicon pig. The metal in contact with the mold begins to cool and forms a crust while the interior remains molten. This crust continues to cool and at the same time contracts, forcing the molten metal strongly towards the center, which makes a solid and rigid joint. The top, or bearing part of the head of the rail is afterwards filed off perfectly level so that it is very difficult to detect a joint by riding over it or looking for it. Upon breaking a joint which has been well cast, three spots (1½ to 2 ins. diameter) will usually be found where amalgamation has taken place between the rail and cast portion; one on each side of the web and the other on the bottom. I cannot recommend this joint with certainty as a bond for carrying electric current, as there are occasional joints where no such amalgamation has taken place, thus destroying the effect as a bond of all joints in that line of track. To overcome this difficulty I have adopted the plan of bonding all joints. However, future experiments and care in the casting of joints may develop greater efficiency as a bond.

The following is an outline of the specifications for track construction used by the Chicago City Ry. Co., and Fig. 7 shows a section of this track:

Excavation.—Excavate to a depth of 9 ins. below the established grade of the street, taking out all dirt for a width of 18 ft.; then excavate for each tie to a depth of 5 ins. leaving the earth between the ties in place.

Ties.—The ties should be of good sawed white oak 5 × 8 ins., 7 ft. long, free from sap; they are laid 30 ins. c. to c., directly upon the ground, and thoroughly tamped with medium-size broken stone.

Rails.—The rails to be used are 9-in. girder rails, 5 ins. base, 60 ft. long; the head to be beveled for two-thirds its width to conform to the bevel of the car wheel. These are laid on the ties and fastened with ½ × ½-in. spikes, 4½ ins. long, 8 spikes to a tie. Double nut tie rods, 1¼ × ⅝ ins. are used, 6 ft. apart; the first and last to be 3 ft. from the ends of the rail. The rails are to have vitrified brick or wooden filling between the paving blocks and the web on each side.

Paving.—The road bed is now filled to within 8 ins. of the top of the rails with medium fine limestone, thoroughly tamped. Upon this are placed 1½-in. hemlock boards running lengthwise of the track. Upon this layer of boards a 1-in. layer of clean sharp sand is laid; and upon this are laid the paving blocks, which should be No. 1 white cedar, 6 ins. high. After being laid the joints are to be filled with good gravel or a limestone screening, tamped in place, the top of paving blocks to be even with top of rail both inside and outside.

Gage.—The gage must be 4 ft. 8½ ins., or ¼-in. wider than the gage kept in the shop for gaging car wheels.

Level.—There must be not over ⅛-in. difference in the height of two opposite rails. Any amount above this will be considered sufficient cause for rejecting such part of track and rebuilding or re-surfacing the same. The foundation should be solid as it is possible to make it. The ties should be of such material that their life will be about equal to that of the rail, if anything a trifle more. The expense of taking up and replacing pavement and repairing defective ties is very great. The wood most generally used, and the one which gives the best satisfaction is good sound white oak free from sap. Its life is about 8 to 10 years under ordinary circumstances. The nature of the soil has considerable to do with the life of the tie.

Brace chairs in place of tie rods cannot be recommended for use with high rails, as they are very apt to bend over in time, but with shorter rails this will not happen.

The paving of a street upon the right-of-way is generally regulated by municipal authorities. Wooden blocks are extensively used in the smaller cities, but in the larger ones they soon wear unevenly and require replacing. Granite block paving is by far the most durable, lasting under ordinary wear in cities 30 years, and should be used where the street traffic is at all heavy. The blocks should be hard, but not liable to become slip-

*Abstract of a paper presented at the convention of the American Street Railway Association at St. Louis, Mo.
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nery by use, the average size being 4×8×12 ins. I advocate small blocks, even as low as 3×6×10 ins.

The cost of one mile of double track with paving for 18 ft. in width of right-of-way, as above specified, based on Chicago prices, would be as follows:

283 gross tons 9-in. 90-lb. rails, at $33	$9,339
4,224 white oak ties, 5 ins.×8 ins.×7 ft., at 38 cts.	1,605
352 cast-welded joints, at $3.50	1,232
1,760 tie-rods, at 15 cts.	264
33,792 spikes, ½ × ⅛ × 4½, at 1 ct.	338
42,240 ft. of wood filler, at ½ ct.	2,112
Labor, at $1 per 1 ft. of D. B.	5,280
10,560 sq. yds. cedar block, at 30 cts.	3,168
146 sq. yds. sand, at $1.25	183
445 cu. yds. crushed stone, at $1.50	668
10,560 sq. yds. gravel and dressing, at 8 cts.	845
10,560 sq. yds. hemlock boards, 2-in., 8 cts. sq. yd.	845
	$25,879

If granite had been used instead of wood block the cost would have been $12,708 more.

The question as to the right time to reconstruct a track is one of the greatest importance as it often involves the expenditure of thousands of dollars. The task of solving this question was brought before me not long ago concerning the State St. cable track, which had reached a deplorable condition. From an examination I guessed that it was time to rebuild the track. This involved a very large expenditure, and to make sure of my guess I had run over the line a car weighing 8,665 lbs., attached behind a grip car by means of a recording spring balance or dynamometer. This test car was then run over a track newly made at the same speed as over the old line; the dynamometer showed that it took 13.75 lbs. more pull per ton to haul cars over the old line than over the new. The average speed of cars on this street is 12 miles per hour. The excess power required to haul one ton was 0.44 HP., and the excess cost of hauling one ton one hour was $0.0088. The number of tons hauled one mile per year on this track was 45,147,537, and the time required to haul one ton one mile was five minutes; and 45,147,537 tons hauled at a given speed for five minutes is equal in work done to 3,762,295 tons hauled at the same speed for one hour; 3,762,295 multiplied by $0.0088 equals $33,108, which is the excess cost per year for hauling cars on account of bad track. It is estimated that the new track with cast joints will last 12 years, and as there will be no low joints the draw bar pull will not increase much until the rail is worn down sufficiently to allow the wheel to run on the flange, so the annual saving will be nearly $33,108, during the life of the rail, and the total saving will be $397,276, which in 12 years will pay principal and interest on $293,444, which is the amount we could profitably expend in repairs. The actual cost of rebuilding this track was $61,670.

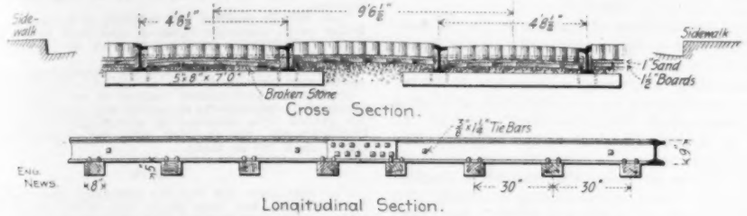

FIG. 7.—STANDARD TRACK CONSTRUCTION; CHICAGO CITY RY.

This caused me to plan a scheme by means of which dynamometer or power ratings could be taken and automatically traced on paper, showing the condition of the track at all points, faults of gage, level or joints; and excess power in consequence of defects, side by side. Further, instead of representing defects in inches and the excess of power in foot-pounds to make the instrument show them in dollars and cents per ton of load when capitalized, which would show, multiplied by the ton miles on any road tested, the amount that could, with good management, be expended on track reconstruction, or rebuilding. The apparatus devised for this purpose is what we call an indicator car. I do not know of another in use by a street railway company, and have found only one other (very dissimilar) in existence on a steam road, after I had the plans of mine finished.*

This car shows graphically high and low rails, low joints and variations in gage, drawbar pull and track level. The car consists of a platform, 8×10 ft., mounted on a single truck, no springs being used. Midway between the two end axles is one which is fitted with wheels which record defects of joints or gage. After use and calibration of instrument it will be more valuable and the dynamometer will not be required, as any man using this car constantly will become so accustomed to the value of defects that a glance at the profile will tell him what money he may, with economy, spend for rebuilding a track or repairing it. The dynamometer consists of two draw bars, one at each end of the car, and extending beneath the platform to within a distance of about 1 ft. of each other. Between the two adjacent ends of the draw bars a spring is placed, and the amount of pull required to draw the car along the track in either direction is recorded by a recording arm, which is connected to the spring with a wire. The apparatus for showing the variation in the level of the tracks is mounted on the platform and consists of two cups of mercury (having a connection between them by means of a pipe) and into which dip two plungers connected to a recording arm. The paper on which the record is taken unwinds at a uniform speed of 1 ft. per 1,000 ft. of track. The car is fastened to an ordinary car, which is drawn over the tracks by horses (or any motor car) made to go at as even a speed as possible. The results shown by a recent test trip are very interesting to compare.

Fig. 8 is from an old track—the joints were the ordinary ones, and were spread far apart, and the rails are low at each joint; this is distinctly brought out by the record. The gage is also uneven. It would appear from the record that the rails spread at each joint. The dynamometer pull is very unsteady, showing the effect of low joints and uneven gage. Fig. 9 is a record from a new track; here we can observe hardly any joints or variation in gage, and the dynamometer pull is more steady. Occasionally high points are observed, but they are due to unsteadiness of speed. A person riding on this track will not be able to detect any joints. This track has the cast-welded joint. We find from the data obtained by use of this car that we could afford to expend $7,383 per mile to repair the old track. The estimated cost of repairing this track, leveling and casting new joints, is $1,740 per mile.

The track maintenance during the year 1895 for the 184 miles of track of the Chicago City Ry. Co. cost $158,217, and represented 17.75% of the total operating expenses. This excessive cost is largely due to a partial or complete rebuilding of many miles of track.

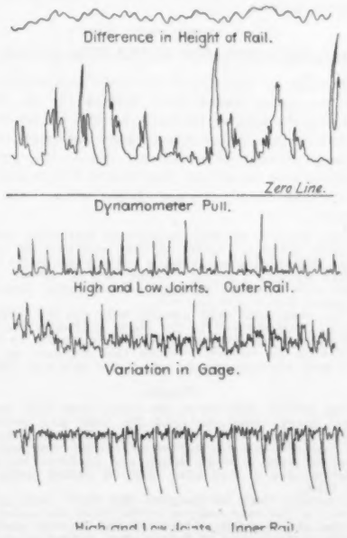
Difference in Height of Rail.
Zero Line.
Dynamometer Pull.
High and Low Joints. Outer Rail.
Variation in Gage.
High and Low Joints. Inner Rail.

Fig. 8.—Track Indicator Diagrams, Old Track.

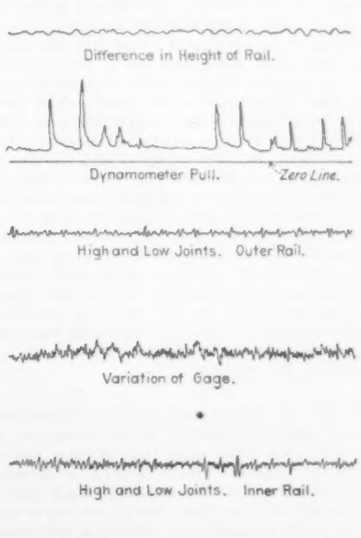
Difference in Height of Rail.
Dynamometer Pull.
Zero Line.
High and Low Joints. Outer Rail.
Variation of Gage.
High and Low Joints. Inner Rail.

Fig. 9.—Track Indicator Diagrams, New Track.

Discussion.

Mr. Robert McCulloch.—We have one piece of track which is 13 miles long, with cast-welded joints, most of it being of 60-ft. rails. We have not an ounce of copper nor a bond of any kind on the entire track. We have made tests of all sorts, with delicate instruments, graded to the thousandth part of a volt, tested as long and as short lengths as possible, sometimes a mile and sometimes a single joint, and have found in most instances that the carrying capacity of the joint was greater than that of the rail at any other place. We have found no necessity for bonding, our contact is perfect at the extreme ends of the rail; and I do not believe it is necessary to bond a welded track. The oldest joints we tested were about six or eight months old.

Mr. Bowen.—For a small road it would be better to let the contractors repair any broken cast-welded joints. For a large system it would probably be better to keep a cupola; you are always building more or less track and doing a considerable amount of repair work. A large system is generally building new track, and you could use a machine and make it pay for itself. The joints that failed, failed on account of contraction, due to very cold weather, in mid-winter. With the first cold snap, the contraction of the rails pulled 154 joints apart. The joints were then repaired, and since then they have gone through the summer the same as the other joints. They were cast in mid-summer, during the night hours. When the joints do part, it is for two or three inches, so that you can see them readily. If there is any oxidation between the joint and the rail, I hardly imagine it would do any harm unless it was sufficient to loosen the cast-iron from the rail proper. In that case it would come apart 3 ins. In repairing a break with a space of 3 ins., we saw a piece of rail and put it in, and recast around the entire two joints.

Mr. Goff.—I have in mind a track which was made up with cast joints in the winter, and in the summer time it seems to be out of line all the time. The car has a waving motion over the track. Do you have any trouble of this nature?

Mr. Bowen.—That comes from the casting. You will find as you put your mold on to cast the joint that the rails have contact at the ball and not at the flange at all. If you are not careful the rail will go out and go up, on account of the majority of the iron being underneath the rail. The contraction in cooling will push it up and push it out. In order to prevent that we put a clamp on the rail when casting it and push it in ¼ in. and down ¼ in. We like to cast at a temperature of between 40° and 50°. There were one or two cases of rails pulling apart. Instead of the fracture being just at the joints, it was some little distance back, probably where the difference between the extreme heat and the ordinary temperature of the rail left a partial fracture.

Mr. Littell.—We have no welded joints in Buffalo. We have the ordinary track laid with 9-in. rail, 94 lbs. per yd. Summer before last we put down some 9-in. rail in hot weather, forcing the rails just as close as we could, leaving them uncovered over night. In the morning we drove the rails up as close as we could, and put them together with a 12-bolt splice bar, 1-in. bolts. We got along very nicely for a time, but winter before last we had one of the 30-ft. rails pull in two 13 ft. from the joint.

Mr. Seely.—We have had 90-lb. girder rails pull in two, on grade of about 5%. We have this occur every winter; the rails break right in the center. The joints are driven too close together. We also find that with the high carbon rails we are using it is almost impossible to cut them with the ordinary tools; we require special devices for sawing rails in two. In sawing rails, if you have to turn them over, they will crack all the way down the center, and we are compelled to handle them with the greatest care.

Mr. McCormack.—Our company in Brooklyn put in 2,000 cast-welded joints on the 94-lb. 9-in. girder rail, and out of that number there was only one which pulled the rail apart; the rail broke about 4 ins. from the end.

Mr. Bowen.—We have 32,000 cast-welded joints, and pay the Falk Co. a royalty for each joint.

*The most complete track indicator, or dynagraph car, is that of Mr. P. H. Dudley, but the Pennsylvania R. R. and some other lines have indicator cars for a similar purpose.—Ed.

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AND
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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

We give a considerable part of our space this week to the papers and discussions at the annual convention of the American Street Railway Association, held at St. Louis last week. The Association is to be congratulated on the excellence of the papers which were read at St. Louis, which seem to us to be distinctly superior as a whole to those which have been read at any preceding convention of this Association. The progress and changes in electric railway engineering have been so rapid in every department during the few years since the electric railway came into general use that it requires vigilance to keep pace with them. Existing literature on electric railway engineering that is of real value to the engineer engaged in actual practice is far from abundant. We believe, therefore, that the papers in this issue on overhead work, power-plant design, and especially the notable features of track construction, will be appreciated by our readers.

In the October advance sheets of "Consular Reports," Commercial Agent H. C. Carpenter, of Furth, Germany, gives some very sensible advice to American manufacturers seeking a broader market for their goods. He tells them that there is such a market in Germany; but it can not be secured by sending catalogues, circulars and other advertising matter to U. S. Consuls abroad under the expectation that these officials will act as their agents. Mr. Carpenter says that the leading industry about Furth is the manufacture of looking-glass plate, and over $1,000,000 worth of this product is annually exported to the United States. But the German manufacturer goes after his market, exhibits his goods, in person or through trusty agents, and by this personal and persistent effort he sells his manufactures. It is pointed out that this rule would work both ways, and Mr. Carpenter shows that there is a fruitful field in Germany for the American manufacturer who will more closely follow German methods in the development of foreign trade. In the line of furniture particularly, there is abundant room for the sale of the well-made solid wood furniture that the United States produces so cheaply. Mr. Carpenter paid $150 for a German dining set, of pine, thinly veneered with a poor quality of oak, which split so badly in six weeks that it had to be repaired. A finer and more durable set could have been purchased in this country for $60. He says that every piece of furniture made in Germany, even down to the plainest, costs from two to three times the price of a better article made in the United States. Farming implements and machinery, house building machinery, boots and shoes are all referred to as products for which Americans could surely find a market in Germany. But the goods themselves must be shown to the Germans, agencies must be established and the American dealer must "hustle for business," to use the expressive remark of Mr. Carpenter. The German leaves the home market to regulate itself while he personally seeks the markets of the world; and we must do the same to extend trade beyond our own boundaries.

The well-known firm of Yarrow & Co., of London, builders of steam yachts and torpedo boats, are said to be considering the establishment of a new works on the Continent with a view, if the result be as satisfactory as is anticipated, of closing their English yard. "Engineering," of Sept. 25, devotes its leading editorial to the subject. The principal reason given is that "foreign countries evidently offer to an astute and successful English manufacturer better opportunities of conducting his business than does his own land." Mr. Yarrow, it is stated, formed one of the party of the Institution of Naval Architects who last spring paid a visit to Germany and inspected many of the shipyards there. "Not a few of the members," says "Engineering," "came back with the unhappy conviction that they would like to exchange yards with at least one they saw during their travels, and that if British builders were to maintain their supremacy they must scrap a good deal of their plant and spend thousands of pounds on new machinery." The chief advantages in favor of a location in Germany as compared with England, are, apparently, the greater cheapness of labor and the greater freedom from obstruction by the action of labor unions.

SPECIFICATIONS FOR WATER-TUBE BOILERS.

The city of St. Louis recently advertised for bids for eight water tube boilers for its No. 3 pumping station, at Baden, and the result of the bidding shows some remarkable features which we deem worthy of comment. From the printed specifications issued by the Water Commissioner, upon which bids were asked, we extract the following:

1. The work to be done consists in furnishing designs and plans, materials, tools and labor and building, transporting and erecting complete in place in the boiler house at High Service Pumping Station No. 3, Baden, eight boilers with furnaces, settings, valves, gages, breeching and smoke flue to core of stack.

2. The contractor shall submit, with his bid, evidence in writing, satisfactory to the Board of Public Improvements, of having obtained with boilers similar to those proposed to be furnished under this contract, an efficiency with common Illinois coal of not less than 65%.

Design.

3. The boilers shall be of the water tube type, having straight tubes, removable from the front and accessible and open at both ends, and no tube shall make a greater angle than 45° with the horizontal, except front and rear connecting pipes between drums and headers. No stays or obstructions of any kind shall be placed inside the water tubes.

The boilers shall be designed and built with special reference to the easy removal of the tubes and access for repairing and cleaning all external and internal surfaces. No part of the boilers or fittings shall extend more than 21 ft. above the boiler room floor.

The furnaces shall be designed to develop the specified capacity of the boilers, without producing smoke, when burning common Southern Illinois coal, and shall have ample combustion chambers.

Furnaces using steam jets in the fire box or combustion chamber, will not be permitted. Mechanical stokers, or furnaces operated by means of a secondary engine, will be tested to ascertain the amount of steam thus used, and this amount of steam will be charged against the boilers in determining the capacity and efficiency.

4. The boilers to be designed for the natural draft of the smoke-stack now under contract, and shown on plans on file in the office of the Water Commissioner.

5. The boilers shall be designed for a working steam pressure of 150 lbs. per sq. in., with a factor of safety of five on minimum sections.

6. Each boiler shall have an evaporative capacity of 9,000 lbs. of water per hour from a temperature of 100° F. into dry steam at 70 lbs. gage pressure, or the equivalent of this capacity.

7. The boilers shall be set in four independent batteries having passage-ways of about 6 ft. in width between them. Each boiler to be provided with walls, settings, valves, gages, smoke-breeching and dampers necessary for operating or repairing it independent of the other boilers in the house.

The clauses of the specification following those above quoted relate to fire-fronts, dampers, valves, steel for drums, settings, tools, quality of material, workmanship, foundations, etc. These clauses number 44 in all, and are given in considerable detail, but they contain no requirement especially difficult to fulfill. After these are the following:

Test for Capacity, Efficiency and Smoke Record.

The boilers shall be tested for capacity and efficiency by the Water Commissioner. One or more boilers shall be tested at a time as may be directed. All boilers under fire in the house shall be tested.

The contractor shall furnish firemen at his own expense during all tests, and shall be given opportunity to make preliminary trials before submitting the boilers for formal tests.

The coal burned during the official tests shall be Mt. Olive Illinois coal, having a calorific value of 11,000 B. T. U. per lb., furnished by the city of St. Louis and delivered to the contractor in the coal house. Contractor will be allowed to pick, air-dry or fork coal if he so desires.

Coal will be sampled and weighed as it comes into the boiler room. Calorific value of coal shall be determined with a Thompson calorimeter, with no correction for moisture.

No allowance shall be made for unconsumed carbon in ashes, nor for temperature of air entering furnace.

During the preliminary testing of the boilers by the contractor, observations on smoke will be made, and until the record thus obtained is satisfactory to the Water Commissioner, the contract tests for capacity and efficiency shall not be made.

Repairs.

One year after the test for efficiency, and before the final estimate has been given, the Water Commissioner will make an examination of the boilers and furnaces and any part or detail found to be defective or injured through bad material or faulty design, shall be replaced by the contractor at his own cost and expense, to the complete satisfaction of the Water Commissioner.

Then follow stipulations in regard to time of completing the work, agreement that the contractor will not sublet the work, and that he will protect the city from demands for patent royalties, damage suits, etc. The guarantees of capacity and efficiency and the premium and penalty clauses are as follows:

The party of the first part shall further agree that each boiler furnished under this contract shall have an evaporative capacity of 9,000 lbs. of water from a temperature of 100° F., to steam at 70 lbs. gage pressure in one hour, or the equivalent of this capacity. Steam generated under the above conditions shall not contain more than ½ of 1% of moisture. The capacity to be determined by the Water Commissioner.

The party of the first part hereby agrees that the boilers furnished under this contract shall attain, during a test of 24 hours or more, an efficiency of 70%; i. e., they shall utilize in heating and evaporating water, 70% of the total heat units contained in the coal as determined with the Thompson calorimeter.

The party of the first part further agrees that in case either of the eight boilers fails to attain an efficiency of 70% during the efficiency test he will pay to the party of the second part, as an agreed measure of damages for lack of efficiency, an amount to be determined in the ratio of $500 for each per cent. which the efficiency of each boiler falls below 70%.

In case any boiler, during the efficiency test, exceeds an efficiency of 70%, the party of the second part agrees to pay the party of the first part, as compensation for the superior efficiency of the boilers, an amount to be determined in the ratio of $250 for each per cent. which the efficiency of each boiler exceeds 70%.

The eight-hour labor ordinance of the city of St. Louis, approved Dec. 22, 1891, is then made part of the contract, as follows:

All contracts hereafter entered into where the city of St. Louis is a party, for the doing of any kind of work or labor for the city of St. Louis, including work on all public buildings, works and enterprises, shall contain the following terms and conditions: (a) That the men, persons or laborers who may be employed in the doing, prosecuting or accomplishment of such work done by the contractor with the city of St. Louis, or any one under him, or any person controlling the said men, persons or laborers, shall not be required to work more than eight hours per day; (b) That in case of the violation of such provisions of such contracts, the Mayor shall immediately declare such contracts cancelled and forfeited, and the work being done under such contracts shall be relet in the manner provided for the letting of such work, and such contractor shall thereafter be ineligible to bid upon such work under such reletting, and the difference in the cost of doing such work under such contract so cancelled and forfeited, and under such reletting, shall be sued for on the bond of such contractor so violating such contract.

It will be observed that there is not a word in the specifications concerning the size of the boilers or furnaces, the areas of grate and heating surface, nor the dimensions of any of the parts. Instead of specifying how large a boiler and how large a furnace is desired, the specification merely states that each boiler shall have an evaporative capacity of 9,000 lbs. of water per hour from feed water at 100°F. into steam at 70 lbs. pressure, that the furnaces shall be designed to develop the specified capacity of the boilers without producing smoke, and shall have "ample" combustion chambers, and that during a test they shall utilize 70% of the heat units contained in the coal, as determined by a Thompson calorimeter.

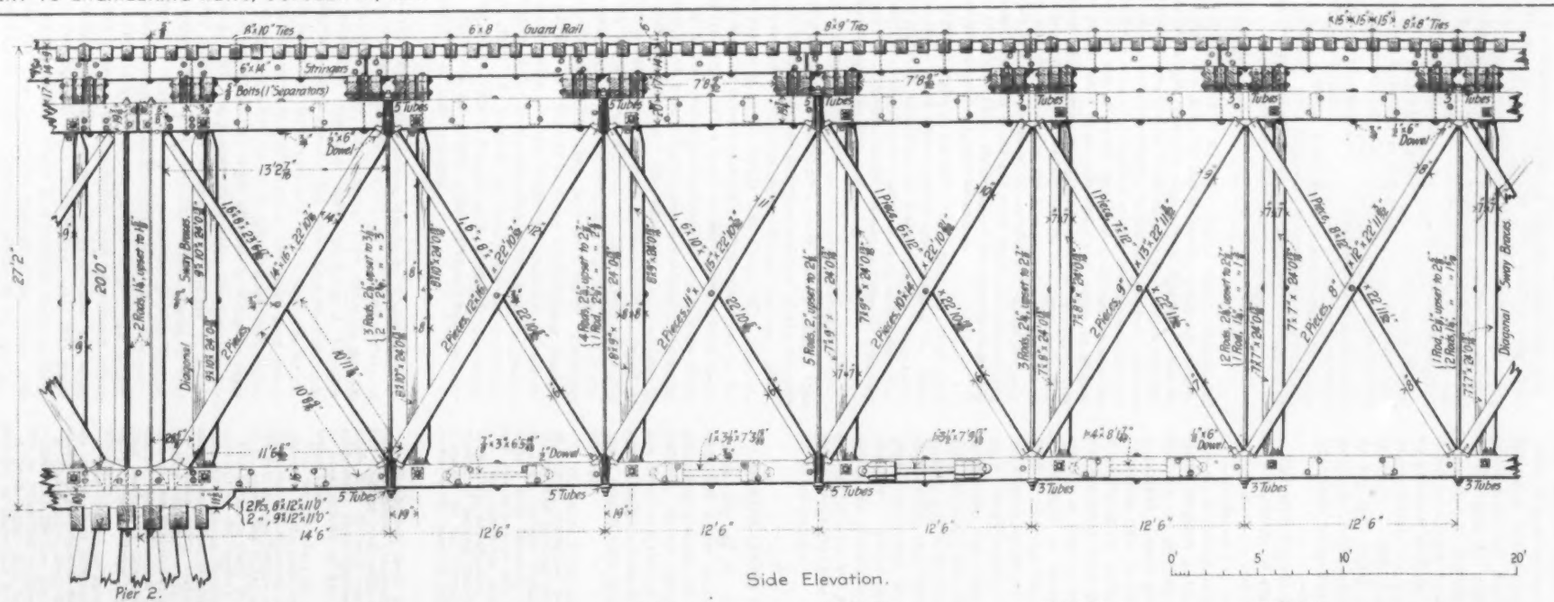
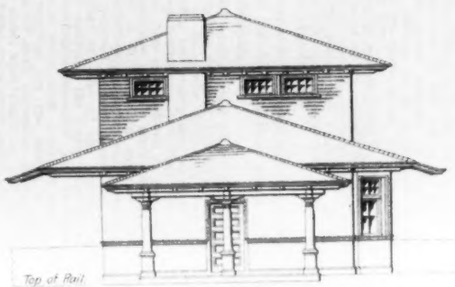
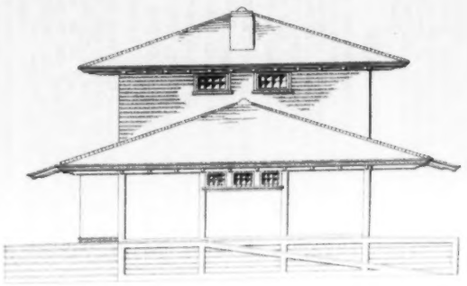


FIG. 3. HOWE TRUSS DECK SPAN OVER THE SAN JOAQUIN RIVER.



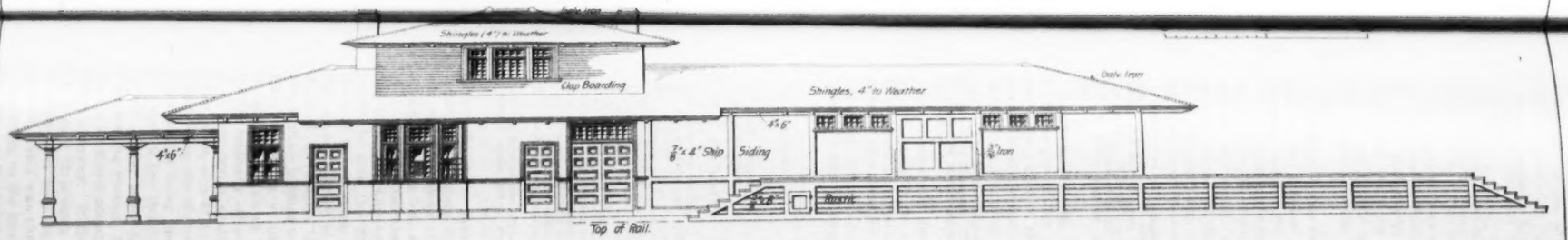
Passenger End Elevation.



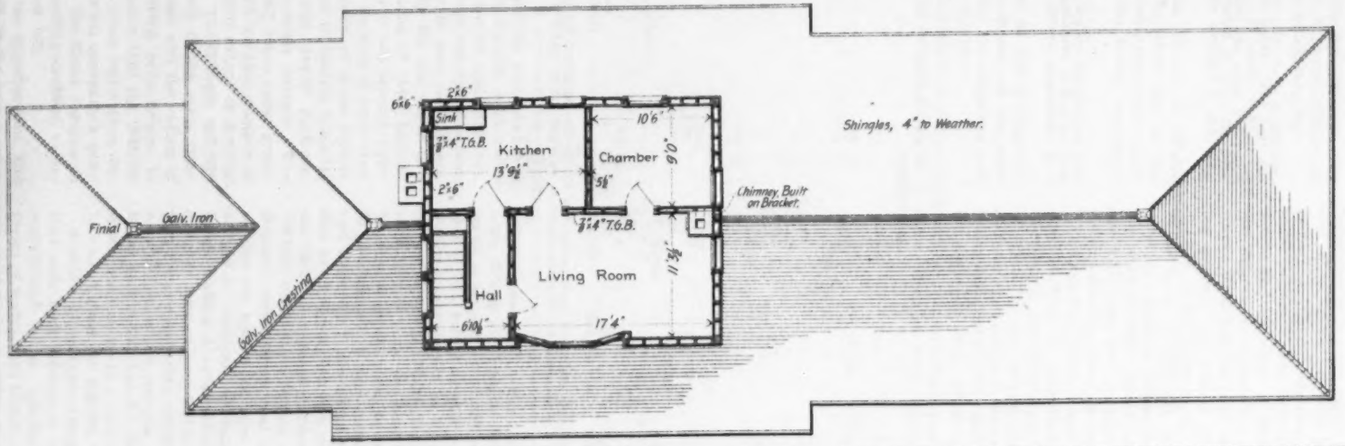
Freight Room Elevation.

Passenger End Elevation.

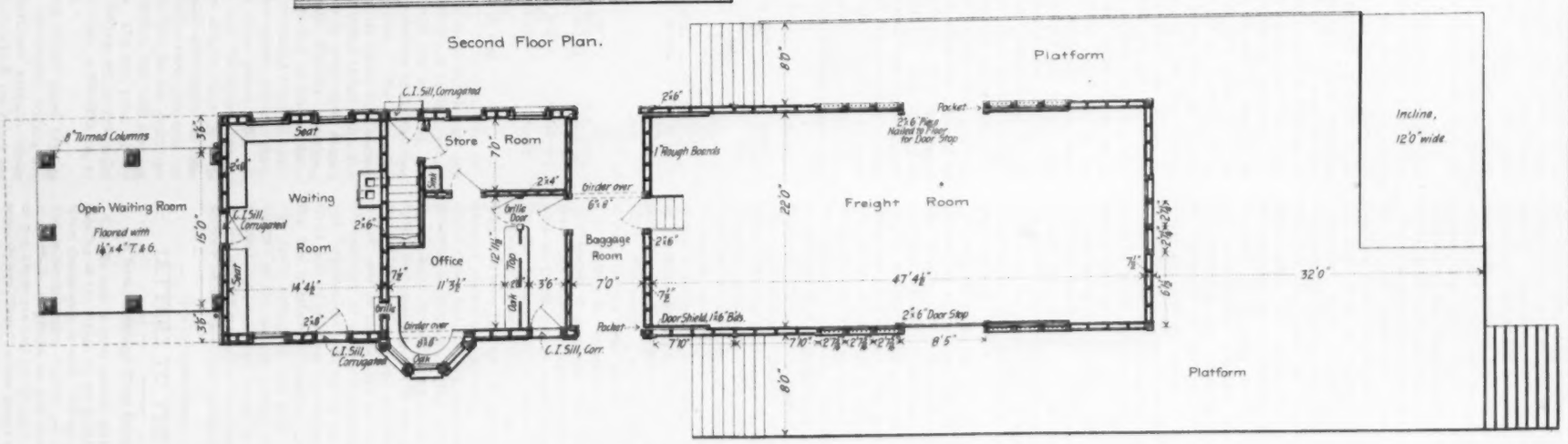
Freight Room Elevation.



Elevation Towards Track.



Second Floor Plan.



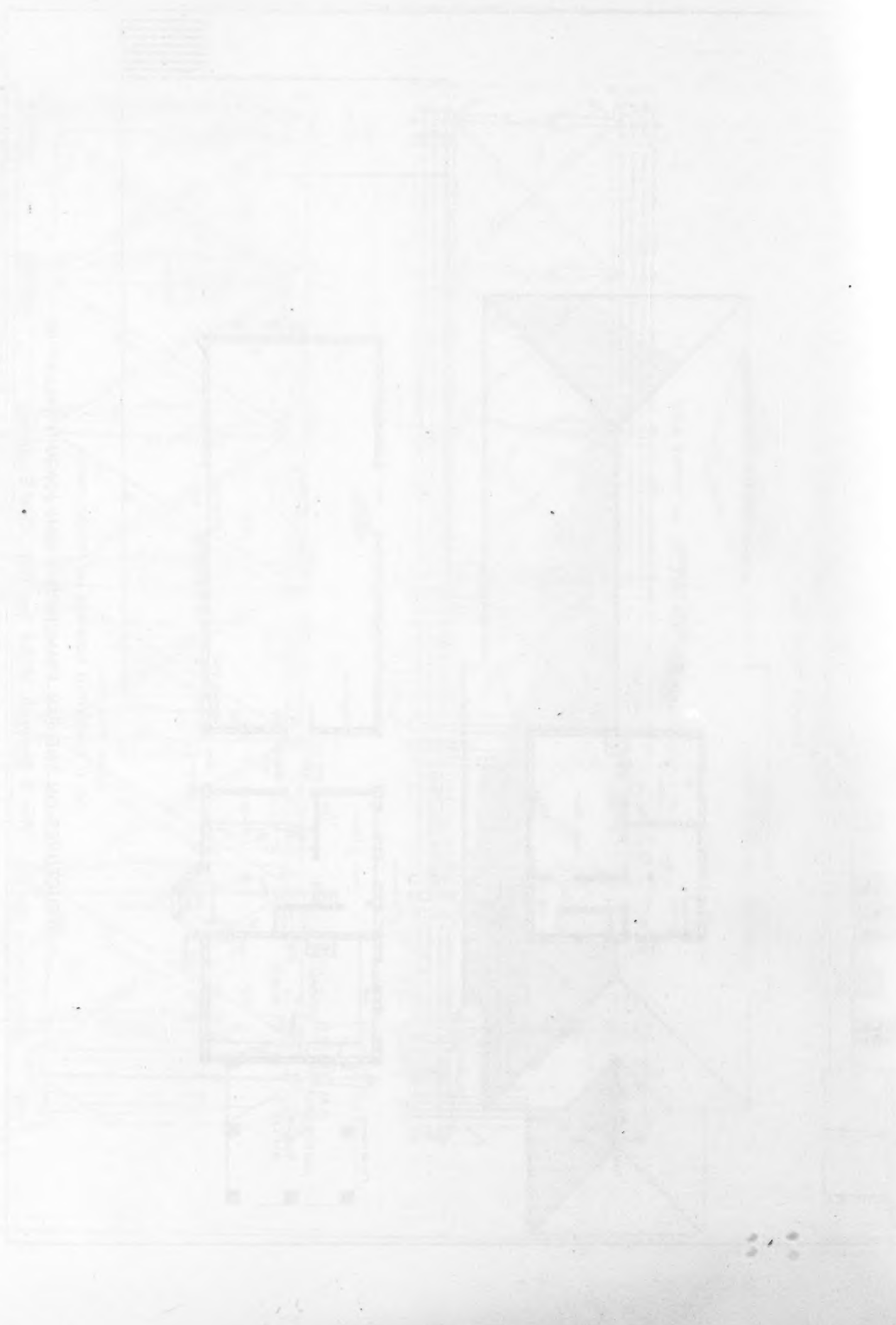
Ground Floor Plan.

FIG. 4. COMBINATION PASSENGER AND FREIGHT STATION.

STRUCTURES ON THE SAN FRANCISCO & SAN JOAQUIN VALLEY RY.

Wm. B. Storey, Jr., M. Am. Soc. C. E., Chief Engineer.

CHAS. HART & SONS, LITH., 34 VESEY ST., N. Y.



The result of the advertising for bids was that only four bids were received, as follows:

Water Department, Letting No. 5034, Sept. 8, 1896.
Abstract of Proposals for Eight Water Tube Boilers at Baden:

Heine Safety Boiler Co., St. Louis, Mo.	$24,950
John O'Brien Boiler Works Co., St. Louis, Mo.	22,300
Geary Water Tube Boiler Co., Oil City, Pa.	50,000
Abendroth & Root Mfg. Co., New York city	52,000

With the bids there was received a protest from the Heine Safety Boiler Co., dated Sept. 8, stating that it had reasons for believing that the boiler tendered by the John O'Brien Boiler Works Co. were "to all intents and purposes Heine Safety Boilers, and as such directly infringe our patents."

In response to this the O'Brien company filed, on Sept. 10, an opinion by Knight Bros., patent attorneys, dated Nov. 25, 1895, to the effect that a boiler made according to a certain blue print furnished by the O'Brien company could be built without infringing any one of three Heine patents, because all the patents had expired. The Heine company then, on Sept. 12, wrote a letter to the Water Commissioners, in which they say:

We have two suits against the city of St. Louis connected with its use of the Geary boiler. The more important one and the one which will chiefly warrant the consideration of your Board is that one which is brought upon our patent No. 529,741, issued on Nov. 27, 1894, to E. D. Meier, and by him duly assigned to this company.

Mr. M. L. Holman, M. Am. Soc. C. E., Water Commissioner of the city, to whom we are indebted for copies of the specifications and of the correspondence relating to the Heine company's protest, now writes us:

As the city desires to purchase boilers and not law suits all bids were rejected. The department is now at work on plans and specifications for boilers preparatory to a new letting.

Mr. Holman also furnishes us the accompanying table, which he says contains all the data which could be obtained from the drawings and descriptions submitted with the bids:

Data on Boilers for High-Service Pumping Station No. 3, Baden, Compiled from Drawings Submitted with the Several Bids.

	Heine.	Root.	Geary.	O'Brien.
Grate surface:				
Upper, sq. ft.	37.125	Not shown.	Not shown.	46.25
Lower, " "	40.55	" "	" "	50.875
Per HP. (upper) " "	.1256	" "	" "	.154
Heating surface:				
(Tube) " "	1,822.1	" "	" "	2,863.
(Shell and header) " "	135.7[1]	" "	" "	110.6
(Grate) " "	106.9[1]	" "	" "	100.9
Super-heating surface " "	None.	" "	None.	None.
Heating surface per HP. " "	6.94[2]	" "	Not shown.	10.27
Steam space, cu. ft.	117.[2]	" "	" "	238.1[2]
Water space " "	325.[1]	" "	" "	523.8
Number of tubes	115.	" "	" "	171.
Tubes, diameter, ins.	3½[1]	----------	" "	2½[1]
Tubes, length, ft.	16.[1]	18[1]	" "	16.[1]
Shell, diameter, ins.	48.	Not shown.	48[1]	36.[1]
Shell, length	18 ft. 6 ins.[1]	" "	22 ft.	19 ft. 3 ins.
Ratio, heating surface to grate surface	56.2 to 1[1]	" "	Not shown.	68.7 to 1[1]
Ratio, air space to grate surface	2.89" 1	" "	" "	1.90" 1
Area of single opening to flue, sq. ft.	11.8	12.5	6.13	Not shown.
Area of opening to stack fr. flue " "	45.	90.	50.	" "
Eight water tube boilers, complete	$24,950	$52,000	$50,000	$22,300

[1]These figures are scaled from the drawings—all others are taken from dimension figures.
[2]Steam space given for the O'Brien boiler includes a steam-drum 30 ins. diameter x 7 ft. long.

From the above table it will be seen that two of the four bidders did not furnish with their bids the dimensions of the boilers and furnaces, upon which they bid, and from the specifications of the Water Commissioner it does not appear that there was any necessity for the other two bidders to give the dimensions of their boilers. From the figures given by these two bidders, however, we are enabled to form an idea of what they proposed to furnish. According to these figures both of these bidders intended to furnish a double grate, consisting of upper and lower portions, probably the Hawley down-draft furnace. The O'Brien company offered 24.6% more upper grate, 25.4% more lower grate, 48.7% greater number of water tubes, and 47.9% greater extent of heating surface than the Heine Co. The O'Brien and the Heine boilers being practically of the same type, as stated in the Heine protest, and the rating of boilers of the same type being proportional to their heating surface, it appears that the O'Brien company offered about 48% more boiler than the Heine company. If the O'Brien company's price had been a little more than the Heine company's it would have been an interesting problem to determine which was the lowest bid.

According to the letter of the specifications, had the Heine boilers been offered at the lowest price, the Heine company's would have been the lowest bid; but, according to the dimensions of the thing offered, the O'Brien company's bid would have been by far the lowest, because for a little more money it offered boilers 48% larger. No such question arose, however, for the O'Brien company not only offered boilers 48% larger, but its price for them was $2,650 less, or 10½% lower than the Heine bid.

The element of guesswork appears to have been an important one in the calculations of one, if not of both, of these bidders, for, having the same performance to guarantee, one bidder offers 6.94 sq. ft. of heating surface per HP., and the other 10.27. Dividing the 9,000 lbs. of water to be evaporated per hour by the area of heating surface offered, one bidder expects to evaporate 4.93 lbs. of water per sq. ft. of heating surface and the other only 3.14 lbs., although the second provides 25% more grate surface, which should be capable of burning, with equal economy, 25% more fuel. The horse-power of each boiler (30 lbs. of water from 100° F. to 70 lbs. pressure being taken as a horse power), is 300 in both cases, or 2,400 HP. for the eight boilers. One bidder offers his boilers at $10.40 and the other at $9.29 per HP., both very low figures for water-tube boilers, including settings. Figuring the price per square ft. of heating surface, one bidder offers 16,677 sq. ft. for $24,950, or $1.50 per sq. ft., while the other offers 24,068 sq. ft. for $22,300, or $0.90 per sq. ft. The other two bidders, whose bids do not give the dimensions of their boilers bid, respectively, $21.67 and $20.83 per HP., or more than double the figures named by either of the two lower bidders.

Perhaps the premium and penalty clauses of the specifications, in connection with the element of guesswork, had something to do with the fixing of prices by the several bidders. The penalty is $500 for each per cent. which the efficiency of each boiler falls below 70%, and the premium is $250 for each per cent. which the efficiency of each boiler exceeds 70%. For the eight boilers one per cent. falling off from an efficiency of 70% would mean a penalty of $4,000, and one per cent. excess of 70% would mean a premium of $2,000. One bidder might reason as follows: "The fair price for my boilers is $30,000, but as water tube boilers with Illinois coal, the coal being tested with the Thompson calorimeter, have in some tests shown 75% efficiency, I can obtain $10,000 premium, and therefore I can afford to bid as low as $20,000, but will put on a few thousand more to cover the risk." Another bidder might reason thus: "While water-tube boilers have shown 75% efficiency, both Illinois coal and Thompson calorimeters are apt to be very erratic, and there is always a likelihood of slight differences of condition making a variation of several per cent. in a boiler test. I had better not be too confident that I can obtain 70% efficiency, but will assume only 65% as a fair margin. The fair price of my boiler is $30,000, but 5% falling off in efficiency would subject me to a forfeiture of $20,000, so, to be sure, I must bid $50,000."

Another remarkable thing about these bids is that only four bidders of water-tube boilers are represented. The specifications exclude those forms of water-tube boilers in which the tubes are not straight, or in which the tubes are at a greater angle than 45° with the horizontal, but they appear to be sufficiently wide to allow bids from the builders of the Babcock & Wilcox; Cahall (horizontal); Edgemoor; Gill; Campbell & Zell; National and Standard boilers, and since a water-tube boiler may be built under the specifications without infringing any unexpired patents, it would appear that they might be met by any boiler maker who has the proper facilities for manufacturing a water-tube boiler.

There is no mysterious property in any one of the several makes of water-tube boiler of the common form, in which the tubes are straight and inclined at an angle of less than 45° to the horizontal, when of approximately the same dimensions of heating and grate surface, supplied with the same kind of furnace, say, the Hawley down-draft, and using the same coal, which should cause one to give any higher efficiency than another. Differences in the apparent efficiences are undoubtedly obtained when the dimensions are different, and when there are differences in the furnaces, in the coal, in the calorimeter by which the coal is tested, in the fireman, and in accidental conditions of the test, such as thickness of bed of coal carried and force of the draft. But none of these difference are due to the type of boiler, and none of them would seem to justify the inclusion in specifications of premiums and penalties based upon "efficiencies" which are calculated from tests of a few grains of coal in an imperfect calorimeter, and the exclusion of what should be the most important feature in a moiler specification, the dimensions of the heating and grate surface.

In saying this, we by no means wish to be understood as condemning the premium and penalty feature in specifications in general. On the contrary, we have in the past advocated this feature in specifications as eminently calculated to stimulate good work on the part of the contractors, and at the same time avoid any difficulty or litigation in case the completed work does not fulfil the contract guarantee. But where a performance is specified in a contract and premiums and penalties are fixed for exceeding or falling below it, that performance should actually indicate the value that the contractor is giving and the purchaser is receiving. The performance of a boiler based on the per cent. of calorific value in the coal burned in its furnaces which is used in making steam, is subject to such large percentages of error in its determination that it does not fulfil this requirement, as we showed in our issue of June 11, 1896. The result of the bidding at St. Louis seems to fully justify what we then said.

According to the letter of Mr. Holman, already mentioned, it appears that the Water Department has learned a lesson from the results of the bids on these boilers, and instead of re-advertising for boilers on the same specifications, it is preparing plans as well as specifications preparatory to a new letting. If the plans are to be of a general character, showing the more important dimensions, but leaving particular details of connections of parts, etc., open for each manufacturer to bid upon those for which he has patterns and tools, well enough, but if the plans show details for which new patterns will have to be made or which can be made only by one or two builders, on account of patent restrictions, then we fear the Department will go to the opposite extreme from that of the first specifications, and by limiting the number of possible bidders prevent the city from obtaining low bids. In any event the results of the second letting will no doubt show a great contrast with those of the first, and one which should make an interesting chapter in the history of engineering specifications.

LETTERS TO THE EDITOR.

A New Mississippi River Dredge.—Correction.

Sir: We note in your usually accurate journal that the capacity of the dredge we are building for the Mississippi River Commission is only "800 cu. yds. per month." As that is the minimum capacity per hour, the discrepancy is startling. In general we may state that it is a machine of just about one-half the intended capacity of the enormous dredge "Beta," whose design and performance were noticed at length in your columns some months ago, and the capacity of 800 cu. yds. per hour will probably be largely exceeded. One special feature of the design is

that it is so far different from all usual arrangements of suction dredges with mechanical excavators as to be entirely outside of the principles claimed by A. B. Bowers as his invention.

Yours truly,
New York Dredging Co.,
By H. S. Wood, Engineer.

World Building, New York City, Oct. 23, 1896.

The Cement for the Melan Bridge at Topeka, Kans.

Sir: In view of the discussion created by the specifications for the Portland cement for the large Melan arch bridge over the Kaw River, at Topeka, Kansas, the information in the fourth of the "Industrial Notes," on p. 131 of the issue of Engineering News of Oct. 15, 1896, may be misleading. Aalborg Portland cement has been chosen under the specifications alluded to, for all parts of the work in which Portland cement will be used, and much of the 5,000 barrels required is now on the ground.

Yours very truly,
Geo. M. Newcomer,
Agent Aalborg Portland Cement Works.

66 Maiden Lane, New York city, Oct. 26, 1896.

(In the "Industrial Note" referred to it was stated that the Diamond brand of cement will be used. This is a natural cement, and according to the specifications published in our issue of April 2, 1896, this cement may be used in the foundation up to a level 1 ft. below low water mark. For all other parts of the work Portland cement will be used, and the very rigid specifications for it were discussed in our issue of May 7.—Ed.)

Noisy Brick Pavements.

Sir: In your issue of Oct. 15 I noticed an article asking for possible explanations of the cause of the noise produced by the passage of vehicles over the brick pavement on McDonough St., Brooklyn. I think that you will find upon inquiry that the joints between the bricks in this pavement are filled with cement instead of sand or pitch. I have, as Borough Engineer, at Plymouth, Susquehanna Co., Pa., had a similar experience with a piece of brick pavement, in which the joints between the bricks for half the length of the street were filled with pitch. The joints between the bricks for the remainder of the street were filled with neat Portland cement. I have often noticed that a vehicle passing along the street would make considerable more noise in passing over that portion of the street that was cemented than it did in passing over that portion with pitch joints. I also know of a piece of pavement in a neighboring city where the joints between the bricks were cemented with like results.

Respectfully yours, Edward H. Post.

Wilkes-Barre, Pa., Oct. 21, 1896.

(Since making the query referred to we note a similar explanation from Mr. E. Adam, Engineer of the Board of Street Commissioners, of Newark, N. J. In this case the rumbling noise occurred in brick pavements with grout filling, and not on pavements with sand filling between the bricks. Mr. Adam was disposed to ascribe the cause of the noise to the slight lifting of the whole pavement from its foundation, by expansion. At the same meeting of the American Society of Municipal Improvements, Mr. N. P. Lewis refers to the experience in Brooklyn, and attributes the cause to the thawing out of the sand cushion, the bricks having been laid in cold weather. This thawing action left voids under the pavement, which would naturally increase the reverberatory effect. As the general experience points to the fact that the noise is much less when the joints are filled with sand or pitch, another explanation might be offered. The use of cement grout practically makes the covering of the street surface a monolithic sheet, fairly well adapted for the transmission of vibrations from traffic and the accumulative effect of sound waves. The use of sand or pitch in the joints acts as a deadener to the sound waves originating in any one brick, and consequently some considerable portion of the sound is absorbed or lost, and the resultant noise is decreased.—Ed.)

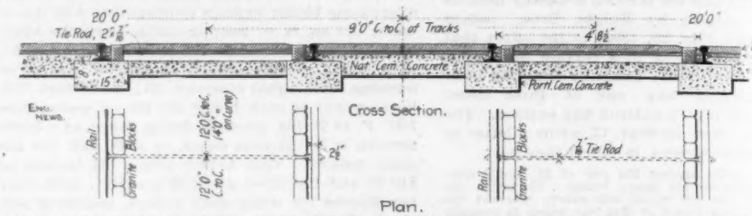
A PERMANENT STREET RAILWAY TRACK.

In discussing editorially "The Street Railway Track of the Future," in our issue of Oct. 15, we called attention to the anomaly which at present prevails in street railway construction of placing a mass of perishable timber beneath the pavement and at the same time using lavishly concrete filling, between, around or under the ties, according to the fancy of the engineer.

Since the publication of that article we have been favored by Mr. Geo. L. Wilson, M. Am. Soc. C. E., with drawings of a method of permanent track construction which has been adopted the past season by the Twin City Rapid Transit Co., operating all the street-car lines of St. Paul and Minneapolis. We print Mr. Wilson's letter with the accompanying plans as follows:

Sir: The subject of street railway track is one of vital interest to all engineers connected with the maintenance of city streets as well as to the street railway companies themselves. As a method of permanent track construction has been adopted, the past season, by the Twin City Rapid Transit Co., that promises to solve the problem as outlined in your editorial of Oct. 15, I send you the accompanying plans, thinking they will prove of interest to engineers engaged in municipal work.

The accompanying drawing is a partial cross-section of an asphalt paved street, with the track construction shown in detail. The rails are laid and brought to grade and line while supported on temporary wooden ties. As the work progresses, after the spaces between the cross ties and under the rails are concreted, the ties are removed and all holes are filled with concrete. The granite blocks along the track are set in place and then left from 10 to 14 days for the cement to thoroughly set, after which the asphalt surface is laid in the usual manner and traffic is resumed. It is an important matter in this construction that sufficient time be given for the concrete to harden before the track is put in service.



PLAN AND SECTION OF PERMANENT STREET RAILWAY TRACK CONSTRUCTION, ADOPTED BY THE TWIN CITY RAPID TRANSIT CO.

The rail used with this construction is a T-rail, weighing 80 lbs. per yd., with a height of 5 ins. and a 5-in. base. The top corner of the head has a radius of 5-16-in. This rail gives good results for a T-rail, except that the depth is not sufficient to allow a proper depth of granite blocks. With a depth of 7 ins. much better results would be obtained in the writer's opinion. The rails are laid in 60 ft. lengths on tangents and 30 ft. on curves. All joints are cast welded.

About six miles of track have been laid the present season, with this construction, by the company referred to, and it is believed that the work will prove a success. For the concrete beam under the rails, Portland cement is used and natural cement for the balance of the work.

We trust that all our readers in any way interested in street railway track construction will give this design the study it deserves. We have seen no more intelligent attempt anywhere to solve the problem of street railway track construction, and the results of experience with it will be awaited with much interest.

A comparison of this track with the very expensive track of the Chicago City Ry. Co., illustrated and described by its Superintendent on another page of this issue, gives rise to many interesting questions. We are without figures as to the cost of the Twin City construction, but we should judge it to be considerably cheaper than the Chicago construction. The former employs a considerably lighter rail, and one which can be bought for considerably less per ton than the girder rail with tram-head used on the Chicago City Ry. It dispenses entirely with ties, and with wooden construction of every sort. As for the relative durability of the two, there is nothing in the Twin City construction to wear but the rail, there is nothing perishable underneath to decay, and if the foundation is solid there appears to be no chance for the track to get out of surface, while the paving holds it absolutely in line. A comparison of the cross-sections will show that a T-rail laid in this way is actually less obstruction in the street than the girder rail with its broad head.

We cannot leave this subject without calling attention to the astonishing feature of the laying of hemlock boards underneath the pavement on the Chicago City Ry. tracks. This sort of paving construction by municipalities was given a black eye long ago; and it is surprising to see a street railway company building track at a cost of $25,000 per mile, and laying hemlock boards as a paving foundation between the rails.

THE MODERN STREET RAILWAY POWER HOUSE.*

By Richard McCullough.†

The cost of power on a large road is only about 10% of the total operating expenses, hence while fuel economy is important, it is far more important that every machine shall be so designed as to insure absolutely reliable service and reduce the liability to break-downs to a minimum.

Location.

A large power house should be placed on a railway track so that coal may be cheaply delivered, and it is also desirable that the location should be where condensing engines may be used, unless the conditions will warrant the use of self-cooling condensers. If a location fulfilling these conditions may be found somewhere near the electrical center of distribution it is an ideal spot for a power house, but if in order to secure coal and water it must be moved from this point, it should, if possible, be moved in the direction of future extensions of the street railroads. The only excuse for not locating on a steam railway is where the interest on the cost of copper feeders running from the steam railroad tracks to the center of distribution would greatly exceed the cost of hauling of coal in wagons.

Building.

There is no reason why anything combustible should enter into the construction of a power house. The walls may be brick, the roof of slate, tile or iron, and the floors of concrete or iron. This obviates the necessity of carrying insurance, the saving of which will in a few years pay the extra first cost. In erecting the building it is advisable to decide first on the style, size and arrangement of the machinery so that no part of the building will interfere with the proper repairs, renewals and inspection of the apparatus. It is a common oversight for railway companies to let the contract for the erection of the power house building, and then find themselves hampered in the use of some particularly desirable form of apparatus by the shape or contracted area of their buildings.

Steam Generating Apparatus.

The proper fuel to use is that which will evaporate the greatest quantity of water per dollar's worth of fuel. It does not pay to burn too poor a quality of fuel, however, because slack containing a great quantity of ash and sulphur will cake and clinker on the grate bars, make a great deal of work for the firemen, and much ash to be removed. In cities where several competing grades of coal come to market, it would probably pay to have expert tests made to determine what grade of coal or what mixture is most economical for the work. In power houses handling large quantities of coal, where the coal is all delivered at the same place, as by rail or boat, the installation of coal and ash handling machinery will generally pay. The advantage of this form of apparatus is its saving in labor, and its disadvantages are its great first cost, its expensive maintenance and the fact that it is desirable for the best service that the coal should be fairly uniform in size, which is a requirement not always easily fulfilled.

In the East the use of mechanical stokers has grown to such an extent that no large power house is considered complete without them. In most of the Western cities, however, and especially in St. Louis, the mechanical stoker has not been a success.*

Boilers may be divided into two general classes, fire tube and water tube. In most of the more recent power houses, some form of water tube boiler has been adopted, as this type possesses some marked advantages over the fire tube. They are non-explosive, they may be operated at a higher pressure and consequently are more suitable for use with compound engines, they have a large heating surface and are quick to respond to calls for power, they occupy less floor space and are usually more intelligently designed than the other class. On the other hand, their first cost is greater, there is a greater number of joints to be looked after and the cleaning is more difficult, especially in those forms which use a curved tube. It has usually been considered that the efficiency of water tube boilers was much higher than the fire tube, but there is now a form of fire tube boiler being made consisting of a shell of large diameter and extra length, containing a large number of flues, which approaches the water tube boiler very closely in efficiency. The high efficiencies obtained in boiler tests are seldom reached in actual practice as they usually result not so much from excellence of design in the boiler itself as from careful and intelligent firing during the test.

*Abstract of a paper read before the St. Louis Convention of the American Street Railway Association.

†Electrician of the Cass Ave. & Fair Grounds Ry. Co., St. Louis, Mo.

*Recent information we have received from St. Louis contradicts this statement.—Ed. Eng. News.

The usual methods employed in heating the feed water are, first by the heat of the exhaust steam, and second by the heat of the escaping flue gases. There are numerous devices for utilizing the heat of exhaust steam, either by passing the exhaust through a number of pipes surrounded by the feed water, or by spraying the feed water across an opening through which the exhaust steam is admitted. Most of these devices are very simple in their construction. Care should be taken that the opening for the exhaust steam is never contracted, so that any possible back pressure on the engine is avoided.

The method of heating feed water by the heat of the escaping flue gases has been applied in apparatus under the general name of economizers. In the use of any device in which feed water is heated by the flue gases, care should be taken that the escaping gases will still retain sufficient heat for the maintenance of the necessary draft after part of their heat is taken from them by the feed water. In the case of power houses using natural draft, economizers should not be used where the draft is not already sufficiently strong, or is just barely strong enough for the work to be done. There are in operation, however, many plants using natural draft, discharging flue gases at a very high temperature, much higher than is necessary to maintain the required draft. Economizers used in such cases would result in a marked gain in economy.

Whatever system of heating feed water is used, the apparatus should be made abundantly large for the work to be done; first, that the water should pass through slowly and receive the full benefit of its contact with the heated gas or steam; second, that a large store of water may be kept on hand, which is of great service in case of a sudden demand on the boilers; and third, that the feed water heating apparatus may act as a water purifier.

With condensing plants the waste from the condensers is never at a greater temperature than 100° F., and if hot feed water is desired, the use of an economizer becomes almost a matter of necessity as the water from the pumps and the other non-condensing machinery would not have sufficient effect in heating the feed water of a large plant.

Several of the large power houses built during the last few years have abandoned the use of stacks for producing draft, and are operating by means of an induced draft produced by fans placed in the flue or short stack. In this case the stack is just high enough to clear the roof. This system has many advantages. First, there are no stacks to blow down or fall down, and this point is of special importance in a region subject to tornadoes. The second and most important advantage, however, is the absolute control which it affords in governing the fires, and this point will appeal especially to those power houses subject to sudden and rapidly changing loads. As an illustration of this may be cited the power house recently erected to operate the Baltimore Tunnel Road. A great part of the time there is no load on the power house as it is only operated when there is a freight train to be hauled through the tunnel. The manner in which the load is handled is as follows: The boiler room is supplied with blowers in place of stacks, and a slow fire is kept constantly under each boiler. When a telegram is received that a freight train is approaching, the blower is started, and on the arrival of the train, steam has been raised in sufficient quantity to supply the great demand put upon the boilers.

The Steam Piping.

In regard to the general plan of the piping, opinion is very much divided. Some favor a single-header with leaders to the engines. Others claim that a complete duplicate system is necessary, so that a failure in any part of the system need not cause a serious stoppage. The objection to a duplicate system is the greatly increased cost. In the installation of a duplicate system, it is only natural that the material and workmanship employed will be cheaper than if a single system were employed, because it is reasoned that if one side breaks down, there is always the other to be depended upon. The other side, however, is often never used until a case of necessity arises, and on account of this very lack of use, the valves and joints are apt to be found leaky and in bad condition when suddenly put in operation. A compromise system has been used in some cases in which all pipes are duplicated, each side, however, having only one-half the capacity required, necessitating the use of both sides at all times. In case of accident to one side the other half of the system may be used, at a disadvantage, of course, by increasing the steam pressure. The best plan, however, seems to be to use a single header divided at convenient intervals by valves, according to the size of the plant and the number of units employed, and to use only the best valves, material and workmanship. The power houses having the least amount of trouble with their piping are those having a simple system. All steam and hot water pipes should be covered so as to prevent as much as possible loss of heat by radiation and consequent condensation of the steam. And in this connection it should be noted that there is a great difference in efficiency in the different kinds of pipe covering. Tests have shown that the magnesia plastic and sectional coverings and the asbestos fire felt covering give the best results. ("Journal of the Association of Engineering Societies," January, 1895.) A water separator should be placed in the leader to each engine. It should be large in size and placed as close as possible to the engine.

Steam Consuming Apparatus.

During the past four years, the street railway generator has undergone a radical change. In the spring of 1893, there were installed in this city in the power house of the Cass Avenue & Fair Grounds Ry. Co., then being built, the first large, direct driven generators of the type which has since become so common. Soon after this the Intramural power house, at the World's Fair, was put in operation, containing one generator of the same size as those in St. Louis and another of twice the capacity. Since that time there have been few large power houses built in which direct driven generators have not been installed, and some of the large railway systems have found that economy of operation required a change from the belt, counter-shaft and unit of small size to the large direct-driven generator. At the present time, the West End Railway Co. of Boston, which may be considered the pioneer in this country in electric traction, is changing its central power station, which had originally been equipped with a very complete and elaborate system of belting and countershafting, to a direct-coupled plan.

The first cost of the direct-coupled generator is about 35% more than the belted generator in the 500 K-W. size, which is the largest standard size in which the belted generator is made; but when the expense of the belt, belt-tightening device, and the floor space is taken into account, the direct connected generator will be found the cheaper. Besides obviating the necessity of the costly and cumbersome belt, the direct connected generator offers the following advantages; in large sizes and in connection with large engines it has a much higher efficiency than the belted unit, it requires a small floor space, it aids supervision by bringing the working parts of the engine and generator close together, it reduces danger, it is almost noiseless in operation, and it may be installed in a larger unit than the belt-driven generator, which is limited in size by the width of the belt and pulley which may be employed. The main objection which was urged against the direct connected generator was the fact that the shocks resulting from overhead loads were thrown directly on the engine and that there was none of the cushioning effect that a belt connection might supply. While this is undoubtedly true, the best argument which may be submitted against it is that none of the installations of direct driven generators can trace any trouble to this source. The large, slow speed, multipolar, direct-driven generator has become perhaps the most prominent feature of the modern power house, and while there may be special services which would necessitate a belted arrangement, it is difficult to imagine a power house thoroughly up to date without direct-driven generators.

By varying the number of poles and the number of armature conductors in the construction of a dynamo, the machine may be designed to run at almost any reasonable speed, the slower the speed, however, the greater being the cost of the dynamo. In the matter of speed it is necessary for the dynamo maker and the engine builder to effect some sort of a compromise, because it is not good practice to run such a large engine at too high a speed. The speeds which are most common are 75 revolutions per minute for the 1,500 K-W. dynamo, 80 to 120 revolutions per minute for the 800 K-W. dynamo, and speeds running from this to 150 revolutions per minute for the smaller sizes. These speeds are what would have been considered, four years ago, quite out of the range of the Corliss valve gear, but the makers of this type of engine have risen to the occasion and now there are numbers of large Corliss engines driving generators at speeds up to 100 revolutions per minute and some have even higher speeds than this. Several other types of engines have been adapted to this work and are running quite successfully. Outside of the question of valve gear, most engines made for this work possess the same characteristics; the heavy bed-plate, the solidly constructed fly-wheel, now being made of steel-plate, the wide cross-head, the large connecting rod and the mammoth main bearings.

The choice between horizontal and upright engines is chiefly one of space. The horizontal engine is the cheaper, the simpler, the easier to inspect and the easier to repair. Outside of the advantage of requiring less space, the upright engine has the advantage of less wear on the cylinder, and a more direct strain upon the foundations.

The usual practice in most modern power houses is to install compound engines. Most of these plants are so favorably situated that condensers may be operated in connection with the engines. This is undoubtedly good practice, but in case condensers are not used the cost of fuel must be very high for the gain in compounding to pay for the extra investment. Where power houses are favorably situated on bodies of water, condensing becomes a very simple problem, but in case the power house cannot be built on a body of water, as in this city, for instance, in order to use condensing engines, some sort of arrangement must be designed to cool a quantity of water so that it may be used over and over again for the purpose of condensing the exhaust steam. Devices of this kind have long been in use in the City of San Francisco and in Cuba, and lately several of the large manufacturing companies have put on the market complete apparatus for the purpose of cooling water after it has condensed the exhaust steam so that it may be used again for the same purpose. Besides the gain in power by using condensing engines it is claimed that by the use of this apparatus, actually less water is used than if the steam is exhausted directly into the atmosphere without condensing.

In the use of large direct-connected units a great deal of the economy to be gained depends upon the selecting of the proper sizes of units. The efficiency of a generator will be good when it is operated at more than 75% of its capacity but the efficiency of an engine drops off very rapidly when it is running below its rated load. In order to achieve the best economy from the use of large direct-connected units, the sizes of the different generators should be so proportioned that it is always possible to operate one or more units at their rated capacity. The railway generator as at present built will stand an overload of 50% for several hours without trouble and at a maximum efficiency. This should be taken into account in the estimate of the dynamos required, but it should always be the aim to have at least one idle machine to throw on the line in case of failure of any of the others. The actual size of the unit depends upon the character of travel which the road possesses and the number of cars, and this must be determined for each road independently. In choosing machines, however, standard sizes should always be adopted as this obviates any trouble in obtaining supplies and repair parts.

The railway generator switch board has become standardized to the extent that it consists of a panel for each generator, each panel containing the usual automatic circuit breaker, ammeter, field rheostat, field switch and main switch. Switch boards as now erected usually contain a recording watt-meter and an ammeter which shows the total output of the power house.

The modern method of line construction is to divide the trolley line into sections and connect each section separately to the main bus bars through feeder panels, each of which contains an automatic circuit breaker, an ammeter and a switch. This method confers the advantages that trouble on the line is always indicated on the proper section, and that in case of short circuits on the line, the main circuit breakers are protected by the section circuit breakers and the load is not suddenly thrown off the engines by the opening of the main circuit breakers. Most of the generator and feeder boards are supplied with devices for preventing damage to the station machinery by lightning, but a very simple and effective arrangement is to connect a large water rheostat between the positive bus bar and a good ground. This is either left in circuit continuously with a small current running through it, or is cut into circuit on the approach of a storm.

Besides those machines which are absolute necessities in a power house, there are various devices which may be added to secure convenience and regulation. An overhead crane is installed in the engine room of most of the large modern power houses and adds greatly to the speed with which heavy repairs may be executed. An oiling system of some sort by which the oil is either pumped or flows by gravity to the different bearings obviates the necessity of manual labor in oiling and insures a steady feed at each bearing. A recording steam gage is found useful in checking up firemen. An air pressure system is beginning to be used in many of the power houses by means of which the carbon dust may be blown out of the armature windings. With this apparatus an armature may be kept thoroughly clean, and the danger lessened of short circuits occurring on account of the collection of carbon dust between its conductors.

A number of power houses operating long lines are now equipped either with boosters or with high voltage dynamos. Long lines usually have a booster constantly in circuit. This machine is automatic in its action and raises the voltage with every increase in the load. Some power houses operate a high voltage dynamo for use on sections which are subject to excessive loads. The feeder boards in this case are equipped with an extra bus bar so that any section may be thrown on the high voltage machine.

While each individual engineer has his own ideas concerning power house construction and while each road building a power house may purchase different apparatus, there is one general design which has been followed in many of the plants recently installed. It might almost be called the Modern Power House. The engine room and boiler room are divided by a brick wall and under different roofs; both are brick buildings covered with an iron truss roof; the boiler room is set on the grade of the street and the engine room 10 or 12 ft. above this grade, the space below the engine room being utilized for the piping and condensers; the engine and boilers are set at right angles to the wall between them, with the engines next to the boiler room so that the piping is made as short as possible and the condensation lessened; the switch board and feeder board are set on the opposite side of the room from the boiler room, so that the length of the dynamo cables is equalized as much as possible. The general features of this design may be summed up as follows: It is compact, to save real estate and buildings and to minimize the number of employees and the

superintendence. Large units are used for the sake of economy and to save the number of working parts.

Figures as to cost of operation, collected from some of the large modern power houses, show that less depends upon the refinements of the machinery than upon the condition in which the apparatus is kept and upon the supervision to which it is subjected. The lowest results are about ¾ ct. per K-W. hour, some records running slightly below this, while the results from some of the large stations are as high as 1¼ cts. per K-W. hour. These figures include the cost of coal, water, supplies, repairs and all labor, but do not include anything for taxes, insurance, interest or depreciation. The cost of operation depends largely upon the cost of coal and upon the relation of the average load to the total capacity of the power house, the higher this ratio the less being the cost of operation.

The modern electric railway power house, although it has been developed entirely within the past ten years, represents the thought and the experience of many men. It has been developed carefully, detail by detail, until it is now a work both of reliability and efficiency. No one man and no one company can claim the credit for this achievement, but no class of men hold a stronger claim to recognition than the managers and owners of street railroad properties, who have ever been ready to encourage with their patronage each improvement, who have freely distributed the information gained by their experience, and who even in the most radical departures have ever acted with the courage of their convictions.

Discussion.

Mr. Rossiter.—I ask if any of the members have had occasion to use the storage battery; and if so, with what success?

Mr. Richard McCulloch.—There is one installed somewhere in Pennsylvania, and the Union Traction Co. of Philadelphia have one installed at the end of one of the long lines for the purpose of regulating the voltage at that point; but there is a storage battery in operation in parallel with the dynamos, I think at Easton, Pa.

Mr. B. J. Arnold, Chicago.—During the last year I have had installed in the Chicago Board of Trade plant, as the consulting engineer for that corporation, a battery auxiliary. In my opinion the work of the plant is more severe, if anything, than electric railroad work, because it operates electric elevators in conjunction with constant potential arc and incandescent lights. The elevators take a starting current varying from 0 to 800 amperes, and back again almost instantly, corresponding in abruptness to the load on an electric railway operating three or four cars. In the Board of Trade plant, the battery auxiliary acts as an equalizer and takes the surplus load delivered into the bus bars, when the demand on the line is less than the capacity of the generator, and takes three-quarters of the overload when the pull comes. The result is that with a 75-K-W. generator, running from 7 in the morning until 11 o'clock at night, at its absolutely normal economic load, it produces sufficient energy to operate fifty 2,000 c. p. arc lamps, 600 incandescent lamps, four 30-HP. electric elevators and six 10-I. HP. motors, all running from this one unit, and the unit constantly loaded. That is my experience with the battery, and it is working perfectly satisfactorily, having been running nearly a year and has cost practically nothing for repairs. We have increased the plant by putting in additional plates, because we required additional capacity, but there was no charge for repairs and I am convinced that the battery auxiliary, when there is sufficient lead installed to do the work, is an eminent success for regulating work and economical operation of power stations operating on variable loads. You must get lead enough in the battery to do the work, and having that, you will get good results. I used a battery made by the Electric Storage Battery Co., of Philadelphia, with the Manchester type of positive plate. It makes all the difference in the world if the plate is built for regulation or for slow discharge. This particular type is for regulation and also performs the function of slow discharge, if necessary. The engines and generators stand idle from 11 o'clock at night until 7 in the morning, and the battery does the work through the night. That enables the engine to operate 16 hours a day, with two shifts of labor, at its economic normal load and shut down at night until morning. The same thing can be done in a large number of electric railway plants in this country with success. It is only a question whether the increased economy will be more than the interest on the investment of the cost of the battery. I am installing now three different stations, part railroad, and part lighting, in which it is my idea to use batteries, by which I will find it necessary to put in one-third less capacity of engines and generators than would be otherwise necessary.

Mr. Hawken.—What is the life of the plate under constant use?

Mr. Arnold.—The plant has been running only about one year, but the depreciation is guaranteed at 7½% per annum. On that basis I figure out a marked economy and feel that we are safe because the company behind the battery will stand up to the guarantee. As a matter of fact it has not cost 1% this year; probably it will cost something next year, and so on each year, but the battery company stands behind it.

We use a booster in the station which consists of a motor generator to charge the batteries, if it ever becomes necessary, while the generators are running on the lines, because then the voltage must remain constant at 125 volts. Then if we wish to charge the batteries we use the auxiliary booster to charge the end or regulating cells, while the shunt winding of the generator is working in parallel with elevators and about 60 of the cells. The elevator service is such as to allow the battery to be charged and discharged in about equal proportions through the day, so that it is practically fully charged at the end of the day's run, and at night if they are slightly discharged we charge them up with the booster by placing the generator end of it in series with the main generator, and at 11 o'clock shut down the engines and run the lights until morning with the batteries. In a railroad power station it would be necessary to use the booster to increase your voltage on your long feeder. If the battery was located at the end of the line you would have to use the booster to overcome the pressure at the battery, or else run a separate high voltage generator.

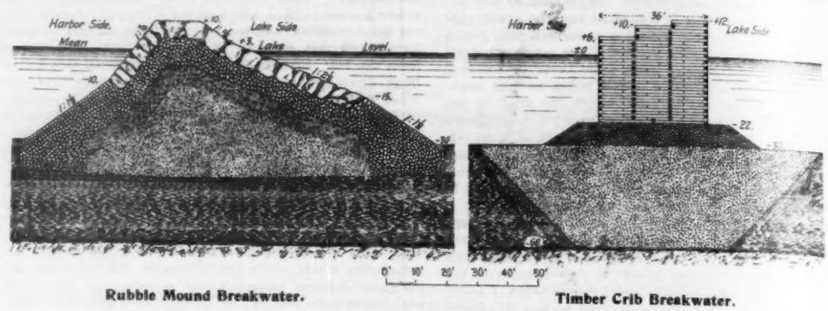
Mr. Harrington.—I understand from the experience of a large number of railway engineers that on the ordinary size plant, running from 40 to 250 cars where the load constantly changes, by reason of trouble on the line, the standard forms of multipolar generators flash from brush to brush, and cause a great deal of trouble in the commutators of the machine. That is a common occurrence in the Philadelphia Traction Co.'s plant. We have had it in our own plant with both Westinghouse and General Electric machines. The storage battery would be an excellent thing to avoid that form of breakdown or delay, due to the burning of the commutator.

THE BREAKWATER EXTENSION AT BUFFALO, N. Y.

Proposals are now being invited by Major T. W. Symons, Corps of Engineers, U. S. A., for the construction of 12,500 ft. of breakwater extension and rectly south to Stony Point; with a middle and south entrance, and with the breakwater constructed partly of rubble mound work and partly of timber crib.

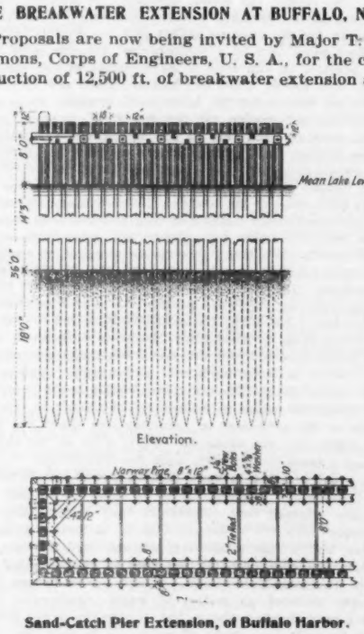
The illustrations, taken from the government specifications, show the general construction of both the rubble and timber work; and show it so plainly that little explanation is needed. The length of the rubble mound will be about 5,000 ft. and that of the timber crib about 7,500 ft.

The rubble mound breakwater will consist of a core of gravel, or other specified material, covered with ordinary rubble stone and capped by large stone. It will extend 10 ft. above mean lake level and have a top width of 15 ft. with a harbor slope of 1 on 1½, from the lake bottom to 10 ft. below mean lake level, and a slope of 1 on ¾ from that point to the top. On the lake side the slopes will be 1 on 1½ from the lake bottom to a point 15 ft. below lake level; 1 on 2½ from this point to 3 ft. above lake level, and 1 on 1½ from the latter point to the top. The gravel core is to have a base of 100 ft. and a general height of 26 ft. above the lake bottom when the material has settled. The rubble stone used is to be as nearly cubical as possible, and at least one-fourth of the volume must be in pieces of 300 lbs. and over in weight. The stone will be dumped from scows on lines established by range-piles and buoys, and the total amount required is estimated at 320,000 cu. yds. The amount of gravel required is about 640,000 cu. yds., scow measure. The capping stones must not be less than 2 ft. thick, and delivered in blocks weighing from 3 to 10 tons and upward; at least one-half the stones must weigh 5 tons and none less than 3 tons.



Rubble Mound Breakwater. Timber Crib Breakwater.

TYPICAL CROSS SECTION OF NEW BREAKWATER FOR THE HARBOR OF BUFFALO, N. Y.



Sand-Catch Pier Extension, of Buffalo Harbor.

for a sand-catch-pier extension at Buffalo, N. Y. At the present time a breakwater, about 8,000 ft. long, lies parallel to and about 3,000 ft. off the shore, at that city, with its northern end and main entrance about opposite the Erie Basin. This breakwater lies in water about 31 ft. deep and encloses a narrow harbor with about 20 ft. of water. It is now proposed to extend this structure di-

For the timber cribwork a trench, 50 ft. wide at the rock bottom, must first be excavated through the soft material. On parts of the location the water is 30 ft. deep, and the mud deposit averages 38 ft. in thickness. The rock along the greater length of the pier lies from 59 to 77 ft. below the water surface, and the bottom deposit varies from 27 to 49 ft. in depth. The trench excavated must be backfilled to the level of the lake bottom with gravel, or other acceptable material, as a stable foundation for the cribwork. Upon this gravel will be deposited a layer of rubble stone, 50 ft. wide on top and 22 ft. below mean lake level. At least 10 days must be allowed for the settlement of the trench filling before the rubble foundation is put in place. The amount of this rubble is estimated at 126,000 cu. yds.

The timber cribs will be 36 ft. wide and 22 ft. high, with the tops, as sunk, at mean lake level. The three top courses and the upright posts in each crib will be made of white pine, and the remainder of hemlock timber, with the timbers varying in length from 10 to 36 ft. Each crib must be 60 ft. long, or as much longer as the contractor can make it, under the specified conditions. Each crib will be built with a grillage bottom, solid outer walls and tiers of cross and longitudinal stringers, and finally filled with stone and solidly decked over, as indicated in the cut.

A continuous timber superstructure is to be built over the cribs, 12 ft. high on the lake side for a width of 12 ft.; 10 ft. high in the middle for a width of 12 ft., and 6 ft. high on the harbor side for 12 ft. in width. This superstructure must be built of white pine sticks, 12 ins. square and from 10 to 36 ft. long, bolted and dowel-bolted and made with solid outer walls and cross and longitudinal

stringers. The superstructure is also to be completely filled with stone and decked over with white pine planking.

The sand-catch pier will connect the shore with the established pier-head line, and will be made up of two rows of close piling, 8 ft. apart between centers, and secured by waling strips 8 × 12 ins. along the inner and outer faces of each row. These rows of piling will be joined by iron tie-rods. This work is under the charge of Major T. W. Symons, Corps of Engineers, U. S. A., and proposals are to be received until Nov. 30.

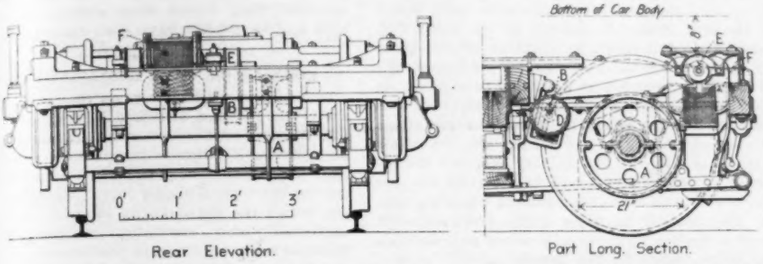


FIG. 1.—DYNAMO AND MECHANISM FOR CAR LIGHTING BY ELECTRICITY; MOSKOWITZ SYSTEM.
National Electric Car Lighting Co., New York.

THE MOSKOWITZ INDEPENDENT SYSTEM OF CAR LIGHTING BY ELECTRICITY.

The application of electric lighting to railway cars has many desirable features to recommend it, and numerous experimental and actual applications have been made on railways in this and other countries, but in many cases the cost of operation has been such as to deter the railway companies from introducing this means of lighting, except on a limited number of high-class trains. In the attempt to devise a commercially practicable system, the most encouraging direction has been that of making each car independent of the others in the train, and various patents have been taken out on methods of driving the generator from one of the car axles. A system of this kind, which appears to possess many practical advantages, is that invented by Mr. Morris Moskowitz, which has been under experimental development for some years. The system comprises a dynamo driven from one of the car axles, a storage battery in two sets, a switchboard and a lamp circuit in the car. It is entirely automatic, requiring no special attendant, and only requiring inspection at intervals of about a week. The system is now being introduced by the National Electric Car Lighting Co., 30 Broad St., New York city, and we are indebted to Mr. Max E. Schmidt, M. Am. Soc. C. E., of that company, for blueprints and information used in this article.

The general arrangement of the apparatus is shown in Fig. 1. On the truck axle is clamped a split pulley, A, which is made of wood specially prepared to be impervious to atmospheric effects, and weighing 35 lbs. The cast-steel countershaft B carries two pulleys, C and D, the former of which is driven by a belt from the main pulley A, while a belt from the latter drives the pulley E, on the dynamo shaft. The countershaft B is carried in spring-cushioned bearings on the inner side of the transverse member of the truck frame, near the king bolt, and the weight of shaft and pullies is 80 lbs. The belts are of a double thickness of leather specially prepared so as not to be liable to be affected by changes of weather or by dampness, snow or ice. The dynamo, which weighs 300 lbs., is attached to the outer end of the truck frame, so that it can be readily inspected, t is enclosed in a dust-proof and weather-proof steel cylindrical casing. The vibrations from the car axle are taken up by a pair of powerful spiral springs, attached to the countershaft B. The bearings of this shaft are interchangeable, and are lubricated about once a week with a heavy lubricating grease. Oil wells (with a supply for one week) and several self-oiling rings are attached to the dynamo shaft bearings. The brushes are specially manufactured to ensure a life of several months in service. The dynamo is self-regulating for the varying rates of speed of the train, and it is claimed that at a train speed of 60 miles per hour the voltage of the dynamo is only three volts higher than at a speed of eight miles per hour, this result being secured by the company's new patented method of dynamo winding. The dynamo does not generate any current as long as the speed of the train is below eight miles per hour. To provide for the movement of the car in opposite directions, it is necessary that the dynamo should generate the current in either direction, and to effect this the electric poles are automatically changed in accordance with the direction in which the car is moving, so that the dynamo generates current at all times when the speed exceeds eight miles per hour, no matter in which direction the car is moving. This pole changing device is one of the special features of the Moskowitz system.

All the time the train is running, and also when the train is at rest or moving at slow speed, as in stopping or starting at stations, the current for the lights is supplied by storage batteries of a special type, owned by this company. These batteries are carried in two wooden boxes under the car, and while one set is furnishing light the other is disconnected and is being charged from the dynamo. If the batteries are first charged sufficiently to furnish light for six hours, the plant will furnish light for from 10 to 15 hours every night, as long as the car is kept running. When put on the sidetrack the batteries are shut off, and the stored batteries are ready to furnish light at a moment's notice.

The switchboard in the car is shown in Fig. 2, and includes the electro-magnetic devices for charging the electric poles automatically when the motion of the car is reversed, and also several other novel automatic devices. The main switch, A, controls all the circuits, and is kept closed, while the dynamo is generating current. The switch of the main light circuit is at B; the ammeter, C, shows the quantity of current generated, and D is a small resistance coil for the light curcuit, which can be used if desired, but is not necessary. The main circuit between the dynamo and the storage battery is automatically opened and closed by means of the difference of pressure between them. The twelve-point switch, E, controls the connections between the two sets of storage batteries. When the battery that is furnishing light is exhausted, the switch is turned, throwing the charged battery into service and connecting the exhausted battery with the dynamo for re-charging. The switchboard can be attended to by a brakeman. The lighting equipment for an ordinary passenger car is 14 incandescent lights of 16 c. p., 12 of these (in four three-light groups in the roof, or else separately alongside the edge of the monitor roof) being in the body of the car and one over each platform. Owing to the use of the batteries the light is maintained quite steadily, there being no direct current from the dynamo to the light circuit.

One car equipped with this system is now running on the Pennsylvania R. R., between New York and Philadelphia. This car has 15 lights; 12 in the main part of the car, 1 in the hood over each platform, and 1 at the switchboard in the

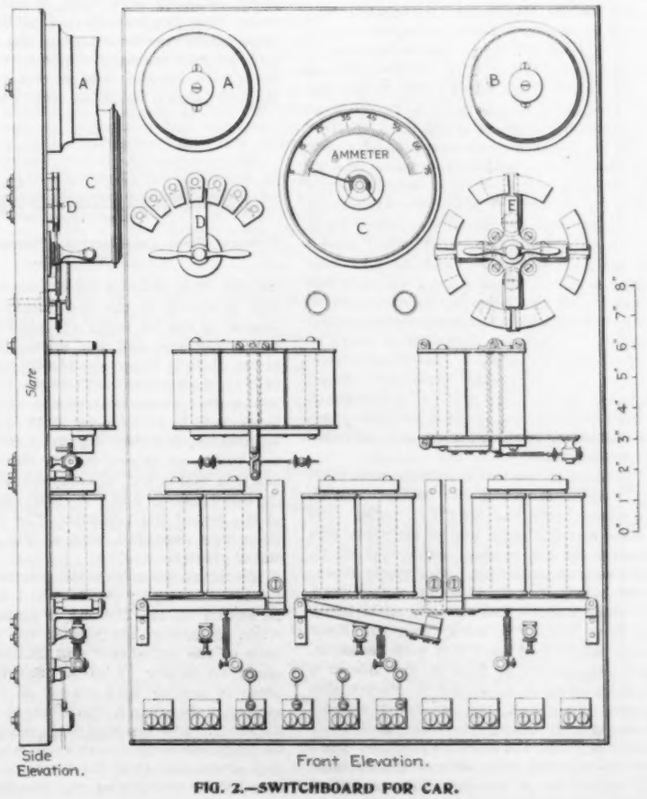


FIG. 2.—SWITCHBOARD FOR CAR.

brakeman's closet; either of the last three lights can be turned on or off at will, and the last named is removable, with flexible cord attachment so that it can be used under the car when oiling or inspecting the dynamo. The car is an ordinary Pennsylvania R. R. day car, with a wide shallow monitor roof, the lamps being placed along the lower edge of the monitor roof. The lamps have short bulbs and filaments, and the bulbs are set in ornamental glass holders. They are 32-ampere lamps of 16 c. p. The batteries are in a box under the car, and the two sets comprise 32 cells weighing 45 lbs. each, or 1,440 lbs. in all. The cells have watertight rubber covers, and the only loss of the acid is by evaporation, which is very slight. The batteries will supply the car with light for 15 hours. This car is run on the westbound express train leaving New York at 6 p. m., and arriving at Philadelphia at 8.30 p. m., making only two regular stops. The return trip is made with the eastbound "owl train," leaving Philadelphia at 12.01 a. m. (midnight) and reaching New York at 3.53 a. m.; this train makes 26 regular stops and 5 extra stops on order. The westbound run tests the efficiency of the mechanism, while the eastbound run tests the electrical efficiency in securing steadiness of light. A chair car for the Atchison, Topeka & Santa Fe R. R., to run between Chicago and Kansas City, is now being equipped with this lighting system at the Newark works of the company.

The principal claims made for the Moskowitz system are as follows: High efficiency, moderate first cost, small operating expense, simplicity of design, easy and infrequent inspection, and the absence of skilled or special attendants on the cars.

A TEST OF SLOW-BURNING WOOD AND PLASTER CONSTRUCTION.

An interesting test of a partially fireproof construction for halls, stairways, partitions, etc., manufactured by the New Jersey Adamant Co., of Harrison, N. J., took place in a lot in the rear of No. 112 Ocean Ave., Jersey City, on Oct. 26. A member of the staff of this journal was present by invitation. The construction consists in the substitution for ordinary lath and plaster of a "plaster board" made of plaster of paris cast around a core of wood excelsior. The boards are made 48 × 27 ins. in size, by ⅝-in. thick. Two of the four edges are rabbeted for an inch, to allow for overlap of adjoining boards, and the other two edges have cast in them a strip of burlap, which, when placed in the rabbeted joint and caused to adhere by running in liquid plaster, makes a joint which is not liable to crack. In applying the construction to the studding of a partition, the studs being placed 16 ins. apart as is usual, strips of plaster board of the same width as the studs are nailed upon their inside surfaces, then horizontal strips are placed across the space between the studs at intervals of 2 ft., and the whole is then enclosed between plaster boards nailed on both sides of the partition with large-headed nails.

For the purposes of the test a furnace was built of 3 × 4-in. wooden studding and plaster boards, its size and shape being that of a 4 ft. cube. One end of the cube was left open, and at the other was built a chimney 20 ins. square inside and 12 ft. high, of the same construction. The whole structure was plastered over, inside and out, with a thin coat of hard finish. The furnace, after being dried by a slow fire for a week, was half-filled with firewood, which had been wet with kerosene, and the fire was lighted at 2:30 p. m. About a cord of wood was used in all during the test, which lasted an hour and a half, the fire being replenished with wood at frequent intervals. Every effort was made to get as hot a fire as possible. During part of the test the open side of the furnace was partly closed by a wooden door protected by plaster boards, but as it checked the draft to some extent the fire was apparently no hotter than when the door was left off. The fire seemed to have no effect whatever on the structure for the first half hour, except to make a network of fine cracks all over the plastered wall of the inside of the furnace chamber. One hour after starting a crack appeared at the corner of the inside of the furnace and the chimney, but none of the plaster board fell off, and the studding was not exposed more than the thickness of the crack. At 4 p. m. or 1½ hours after starting, the first serious damage to the structure was observed. A portion of the plaster board on the inner side of the roof of the furnace fell in, exposing one side of the studding. The other three sides being protected by the plaster board, however, the studs burned very slowly, and they would probably have lasted half an hour longer if exposed to the same fire, before burning through to such an extent as to drop the roof, but the test was not continued further as all the firewood on hand had been used. It should be said that the inner side of the roof was supported to some extent by thin sheet iron strips besides being nailed to the studs. On the whole the test was a highly satisfactory one, and the resistance of the plaster board to a strong fire for an hour and a half was remarkable, when we consider that plaster of paris alone when exposed to such a fire for 15 minutes becomes so friable as to be easily broken by the fingers.

The construction tested was patented Feb. 12, 1895, by Mr. Jas. D. Baker, of Montreal, Canada. It is manufactured by the New Jersey Adamant Co.,Harrison, N.J. (J. Wesley Dey, president); and by the Hudson Plaster Board Co., 130 Fulton St., New York city.

TEST OF THE RAPP FIREPROOF FLOOR CONSTRUCTION.

The fourth test in the series of tests of fireproof floors, which is being conducted by the Department of Buildings of New York city, was made at 68th St. and Avenue A, on Oct. 26. The test was made in a similar manner to those described in our issues of Sept. 17 and Oct. 1, by making a section of the floor serve as a roof to a brick building 15 ft. long × 12 ft. wide, inside measurement, and 12 ft. high. A floor of grate bars was placed near the bottom and cord wood piled on it. A small chimney was built at each corner of the roof. The fire was started at 10 a. m., and was kept up for five hours, when the door was opened and the roof suddenly cooled by a stream of water from a fire engine. The floor tested was Mr. J. W. Rapp's patent, built by the Rapp Sheet Metal

Fireproof Floor Construction. Patented by J. W. Rapp, New York.

Works, Nos. 309-319 East 94th St. Its construction is shown in the accompanying cut. The I-beams 10 ins. in depth are placed 4 ft. apart between centers, and the lower flanges support a series of light bearers made by bending sheet iron of No. 14 gage into a T-shape, 1¾ ins. high × 1½ ins. wide. These bearers are placed 9 ins. apart, being held in position by light sheet iron strips or separators, and they support a flooring of common red brick, as shown in the cut. On top of the brick is laid a bed of concrete, made of 1 part of Portland cement and 8 parts of cinders, to the level of the top of the I-beams. The under side of the floor was plastered with a thin coating of hard finish plaster.

Within an hour from the starting of the test the temperature under the floor had reached 1,800° F., as shown by the Uehling & Steinbart pyrometer, when a piece of the plaster fell on the platinum tube of the pyrometer and damaged it so that it could no longer be used. Shortly afterwards a piece of copper wire placed in the building was melted, indicating a temperature of from 1,900 to 2,000° F. The fire was maintained at a high heat by frequent additions of cord wood, until 3 p. m. One of the panels of the floor was loaded with pig iron to 150 lbs. per sq. ft. Readings of deflection were made by an engineer's level from time to time. At noon the deflection was 1.35 ins.; at 12:45 p. m., 1.72 ins., and at 3 p. m., 2⅜ ins. After throwing the stream of water on the under side of the floor it was found that the iron strips holding the brick floor had sagged two or three inches, and some of the brick had fallen out in the center, but the bed of concrete remained intact and apparently uninjured.

The whole floor showed a maximum deflection of 2⅜ ins. when the heat was the greatest, but as when cooled the deflection was found to be only 1.2 ins., the maximum deflection was probably due to the lower flanges of the beams being heated more than the top flanges. Apparently, however, the lower flanges were not heated to such a degree as to be seriously weakened, for if this had occurred they would have stretched under the load and would not have gone back when cool.

INDURITE, OR NAVAL SMOKELESS POWDER.

In an interesting address on the development of smokeless powder, delivered before the Washington Section of the American Chemical Society, Mr. Charles E. Munroe describes the result of his own experiments in producing a smokeless powder for the United States Navy. He recognized at the outset the impossibility of obtaining absolute uniformity and constancy of composition in physical mixtures like gun powder and determined to produce a powder which should consist of a single substance in a state of chemical purity. This had never been done before, and has not been done since, so far as Mr. Munroe can ascertain.

He began by purifying dried pulped military gun-cotton by extracting it with hot methyl alcohol, in a continuous extractor, and then drying the insoluble cellulose nitrate remaining. The highly nitrated cellulose was then mixed with a quantity of mononitro-benzine, which scarcely affected its appearance and did not alter its powdered form. This powder was then incorporated upon a grinder by which it was colloidized and converted into a dark translucent mass resembling india rubber. This sheet was cut into flat strips or grains, or it was pressed through a spaghetti machine into either solid or perforated cords of required dimensions, which were then cut into grains. The granulated explosive was then immersed in water, boiling under the atmospheric pressure, by which the nitro-benzine was carried off and the cellulose nitrate was indurated; the mass became light yellow to gray in color and as dense and hard as ivory. It was by this physical change in state, varied within limits by the press, that the material was modified so as to pass from a violent rupturing explosive to a slow-burning propellant. This is the powder called Indurite by Mr. Munroe and popularly known as naval smokeless powder.

On testing, this powder gave remarkably regular pressures and uniform velocities. The powder called for by the naval authorities was required to give a velocity of 2,000 ft. per second, with but 15 tons pressure to the square inch. In two successive rounds, with a 6-in. rapid-fire gun, using 26 lbs. of Indurite and a 100-lb. projectile, the pressures were 13.96 and 13.93 tons and the velocities 2,469 and 2,456 ft. per second respectively. This powder stored for six months, part of the time being very hot, showed absolutely no change in a firing test. All smokeless powders, except Indurite, are mixtures of one or more of the cellulose nitrates, or admixtures of these bodies, with nitro-glycerine, or some other oxidizing agent, like varium nitrate, and a restrainer; and all are condensed or hardened into a rubber-like or celluloid-like form, and are expected to undergo combustion at a moderate and regular rate.

In the same paper Mr. Munroe reviews the history of gun powders from A. D. 1346, and that of smokeless powder from 1845. Any of our readers especially interested in the subject will do well to obtain a copy of Mr. Munroe's paper which may be obtained from the Chemical Publishing Co., Easton, Pa.

AN ENGLISH VIEW OF AMERICAN COMPETITION.

American competition in the cycle trade is announced. A Birmingham correspondent who has business connections on the Continent has recently been staying in Berlin, and on his way visited a few Dutch towns. Whilst traveling, he was much struck with the rapid and increasing sales of American cycles in Germany and Holland, and in Berlin especially a very large number of American machines is to be seen, whereas six months ago they were comparatively speaking unknown. He was told that at nearly all the cycle depots the sales of American machines were on the increase. The correspondent continues: "If wooden rims and very light machines are the demand on the Continent, it surely behoves those engaged in the cycle industry to go with the times." A friend—the representative of a large house dealing in agricultural implements—once told him, and it is more true now than ever,

WEATHER TABLE FOR SEPTEMBER, 1896. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	55.0	90	29	61	8.3	28	N	3.48	1.15	13
	Portland, Me.	57.7	79	36	43	7.3	30	S	9.57	5.28	14
	New York City.	64.8	86	43	43	13.7	56	SE	3.04	1.16	9
	Pittsburg, Pa.	65.2	92	39	53	4.9	24	SW	4.17	1.70	10
	Chicago, Ill.	60.6	88	40	48	16.5	42	N	6.70	2.42	13
	Omaha, Neb.	61.6	88	37	51	7.1	28	S	3.97	1.44	7
	St. Paul, Minn.	56.5	81	32	49	7.3	29	SW	2.45	1.44	8
	Duluth, Minn.	54.6	78	34	44	10.4	38	NE	1.00	0.52	11
	Bismarck, N. Dak.	54.4	93	22	71	9.1	36	NW	1.42	0.53	11
	Average.	58.9	86	35	55	9.4	35		3.98	1.74	11
Southern Cities.	Washington, D. C.	67.8	94	42	52	6.0	66	SE	3.18	1.17	12
	Louisville, Ky.	68.8	97	40	57	6.9	36	SW	4.12	2.74	11
	St. Louis, Mo.	68.2	95	45	50	9.8	31	NE	2.42	0.70	12
	Savannah, Ga.	77.4	97	53	44	6.8	70	SE	2.08	1.53	6
	Kansas City, Mo.	64.8	94	42	52	7.9	29	NE	2.81	0.79	11
	Jacksonville, Fla.	79.2	96	58	38	6.9	70	SE	2.19	0.95	11
	Chattanooga, Tenn.	73.1	98	43	55	5.6	34	NE	2.01	1.20	8
	New Orleans, La.	78.9	91	56	35	7.5	30	N	5.26	3.73	6
	Memphis, Tenn.	72.8	96	41	55	8.4	38	NW	3.21	1.12	5
	Palestine, Tex.	79.2	104	47	57	6.2	26	S	2.01	1.58	5
	Average.	73.0	96	47	50	7.2	43		2.93	1.55	10
Western Cities.	Helena, Mont.	51.8	85	32	53	6.3	30	SW	2.54	0.68	10
	Port Angeles, Wash.	52.6	78	36	42	4.2	23	W	0.91	0.67	4
	San Francisco, Cal.	59.6	81	52	29	10.9	33	SW	0.52	0.41	5
	Salt Lake City, Utah.	64.0	90	36	54	7.0	44	E	0.52	0.25	8
	Santa Fe, N. Mex.	61.2	84	34	50	6.2	25	E	1.39	0.43	12
	Denver, Colo.	61.2	91	37	54	7.1	40	NE	1.81	1.03	8
	Yuma, Ariz.	84.0	108	55	53	5.1	33	S	0.31	0.31	1
	Average.	62.1	88	40	48	6.7	33		1.14	0.54	7

that the American makers of agricultural implements had almost completely ousted the English manufacturers of reapers, binders, etc., in Germany, Russia, Austria and Hungary. The English firms would not listen to the advice tendered them by their agents in great cities and centers, and would not adopt the methods of the Yankee makers, with the consequence that orders were lost, and the trade went to the States. It is to be hoped that this will not be the case with the cycle industry.—The Engineer (London).

ANNUAL MEETING OF THE AMERICAN STREET RAILWAY ASSOCIATION AT ST. LOUIS, MO.

The fifteenth annual meeting of this Association was held Oct. 20 to 23, at St. Louis, Mo. At the opening meeting, with the President, Mr. H. M. Littell, in the chair, the proceedings were opened with prayer by Rev. P. G. Robert, and Mr. Charles Nagel, Acting Mayor of St. Louis, delivered an address of welcome, after which the president delivered the annual address. In his remarks he dealt mainly with the growing disposition of state and municipal governments to increase the burden of taxation imposed upon street railway companies, which is due largely to a popular prejudice against corporations, and the only remedy for which is a gradual enlightening of the public mind and the cultivation of a broad and conciliatory management by the roads. Another severe strain is that of the high penalties imposed by the courts upon the companies for the negligence of their employees. Remedies for this are the education of the public and the employees to the exercise of more care in the use of the streets and the handling of the cars. He closed his address by referring to the great public importance of street railways.

The report of the Executive Committee was then presented, and showed that the membership in October, 1895, was 173 companies; 8 new companies had joined the association; 3 had become consolidated; 1 company had withdrawn, and 13 companies had been dropped for nonpayment of dues, leaving the present membership 164 companies. At the beginning of the present fiscal year the Association was in debt $6,000; this indebtedness has been cancelled, and the income during the forthcoming year will be about $6,500, which will enable the Secretary to enlarge the scope of the work of the Association. It is proposed to issue a monthly bulletin containing information of value to the members.

The report of the Secretary and Treasurer was next read, and the following is a summary of the figures there given:

Receipts	$12,044
Expenses	10,278
Balance	$1,766
Liabilities	381
Net assets	$2,530

The first paper on the list was that by Mr. M. K Bowen, Superintendent Chicago City Railway Co., on "Track and Track Joints, Construction, Maintenance and Bending," an abstract of which, with the discussion upon it, is given in another column.

At the meeting on Oct. 21 the first paper presented was one by Mr. John N. Akarman (Worcester Consolidated St. Ry.), on "Street Car Trucks," and this was followed by a paper on "The Modern Power House," by Mr. Richard McCulloch (Citizens' Ry. and St. Louis Ry.). Abstracts of both of these are published on another page of this issue. A paper on "How Can the Revenues of Street Railways be Increased," was then read by Mr. G. Densmore Wyman (Milwaukee St. Ry.), in which he took into consideration the collection of fares, methods of registering fares, transfers, the use of tickets or cash fares, attractions along the line of the road, etc. He considered that motormen should have some experience in the repair shops before taking charge of cars. After the appointment of a nominating committee the meeting adjourned.

On Oct. 22 the greater part of the morning was spent in examining the extensive exhibit made by manufacturers of and dealers in street railway supplies. When the meeting was called to order a paper by Mr. B. Willard (New Orleans City & Lake Ry.) on "Modern Overhead Electric Construction," was read in the absence of the author. An abstract of this is also printed separately.

The committee on nominations then submitted its report, and officers for the ensuing year were elected as follows:

President, Robert McCulloch, Vice-President and General Manager, Cass Ave. & Fair Grounds Ry., St. Louis, Mo.; First Vice-President, Charles S. Sergeant, General Manager, West End St. Ry. Co., Boston, Mass.; Second Vice-President, D .B. Dyer, President, Augusta Ry. Co., Augusta, Ga.; Third Vice-President, C. F. Holmes, General Manager, Metropolitan St. Ry. Co., Kansas City, Mo.; Executive Committee, H. M. Littell, Vice-President and General Manager, Metropolitan St. Ry. Co., New York city; H. P. Bradford, General Manager, Cincinnati Inclined Plane Ry. Co., Cincinnati, O.; Charles H. Smith, Superintendent, Troy City Ry. Co., Troy, N. Y.; Harry Scullin, Vice-President and General Manager, Union Depot Ry. Co., St. Louis, Mo.; George B. Hippee, General Manager, Des Moines City Ry. Co., Des Moines, Ia.; Secretary and Treasurer, Thomas C. Penington, Treasurer, Chicago City Ry. Co., Chicago, Ill.

The report of the committee recommending Niagara Falls, N. Y., as the place for the next meeting, in 1897, was also adopted. On motion of Mr. I. A. McCormack (Gen. Supt., Brooklyn Heights Ry.) a committee of five members was appointed to consider the propriety of the association adopting a standard code of rules and regulations for the government of employees, similar to that in use on steam railways. The annual banquet was held Thursday evening. At the meeting on Oct. 23 the first business was the reading of a paper on "The Selection and Management of Employees," by Mr. W. F. Kelly (Columbus St. Ry.), in which particular stress was laid upon the necessity of exercising greater care in the employment of men, of properly educating and instructing them, and of properly treating them. This paper brought out an extended discussion, in which reference was made to the provisions now made by several companies for the comfort and convenience of the men, in the way of reading rooms, waiting rooms, baths, gymnasiums, etc. It was also pointed out that punishment by suspension is liable to cause much ill feeling by making the man's family suffer for the period of his enforced idleness, besides tending to injure his character.

After the passing of resolutions of thanks to various persons and associations the meeting adjourned. The convention was well attended, over 1,000 persons being present, and a very good set of papers was presented, but the discussions were not very extended for the reason that the meeting room, in the corner of the Auditorium, was not heated, and the members were therefore not anxious to remain long to talk.

ANNUAL CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

The sixth annual convention of the Association was held at Chicago, Ill., Oct. 20, 21, and 22, 1896, and a programme of twelve special committee reports was presented for discussion. This programme was decreased considerably, however, by the failure of three of the committees to present reports, a request by a fourth for more time, and individual reports by a single member only of two other committees. The reports actually presented were as follows: "Different Methods of Numbering Bridges;" "Drawbridge Ends, Methods of Locking;" "Protection of Trestles from Fire;" "Local Stations at Small Towns and Villages;" "Tanks, Frost-Proofing, Size, Style and Details of Construction;" "Best and Uniform System of Report Blanks for Bridge and Building Department;" "Mechanical Action and Resultant Effects of Motive Power at High Speeds Upon Railway Structures;" "Best and Most Economical Railway Track Pile Driver;" "Span Limits for Different Classes of Iron Bridges." Five of these reports were printed and distributed in advance of the convention, and the others were read from the manuscript.

During the opening session the time was taken up with the usual addresses, reports of officers and other routine business. The secretary's report showed the financial condition of the society to be good, there being a balance in hand above all expenditures of $233. The total membership of the society is 221, of which, however, only about 30 members were present at the convention. Applications for membership from 20 new men were received and the applicants elected. Two members were lost by death during the year.

The first work of the second session was the appointing of committees on nominations, auditing, resolutions, obituary and subjects for discussion. The reports of the special committees were then read in the order outlined above, but as, according to the usual practice, their discussion was postponed until the second day, they will be considered in the proceedings of that day. The review and discussion of the committee reports presented at the preceding year's convention was the next order of business. These reports have already been printed in full in the Association's proceedings for 1895, and in abstract in Engineering News of Oct. 24, 1895, and need not be repeated here. Only three of these reports, viz., "Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burnouts;" "Best Method of Erecting Plate Girder Bridges," and "Sand Driers, Elevators and Methods of Supplying Sand to Locomotives," were discussed at any length, and this discussion consisted largely of a relation of the practice of different members.

In regard to repairing washouts and burnouts, Mr. W. M. Noon (D., S. S. & Atl.) stated that his practice was to keep always a large stock of timber on hand. Immediately a burnout was reported he examined his records to ascertain the character, dimensions, etc., of the destroyed structure and from this knowledge he selected and loaded his material. The force was divided into separate crews to carry out the following duties: Clearing up wreckage; sawing off old piles; unloading material; getting material in place by push-cars; framing; erecting; track construction. Mr. James H. Travis (Ill. Cent.) stated that the main supply yard of the road was at Chicago, where material was always on hand for a 400-ft. or 500-ft. opening. His first concern after getting his material under way was to establish a good commissary, if the work was likely to last more than 24 hours. Work on the repairs was divided into two shifts, one gang commencing very early in the morning and continuing until noon, the other working from noon until 8 or 10 p. m. Pile and frame bents were used to fill the break, the bents being placed 14 ft. c. to c., the caps were 12 × 12-in. timbers and the stringers 12 × 16-in. timbers. When possible piles are always used. The pile driver has a reach of 26 ft. and in first work the pile bents are placed that distance apart, but after trains are running a bent is placed midway between each pair of those first erected. He considered it advisable to work only by daylight when possible, but if work was done by night he preferred a bonfire for lighting to anything else and always carried two or three car loads of wood for that purpose.

Except for difference in detail the methods described by other members varied but little from those of Mr. Noon and Mr. Travis, and those described in the committee report. The discussion on both the other reports mentioned above was brief and added but little new information. The concensus of opinion seemed to be in favor of erecting plate girders on false works along side of the old structure and sliding them into place when this could be done conveniently, but it was considered that in almost every case the best method would vary with the local conditions. As an example of rapid plate girder erection, Mr. M. Riney (Chicago & Northwestern) mentioned the Merrimac River bridge. This work was described in Engineering News, July 9, 1896. In relation to sand driers, Mr. Walter G. Berg (Lehigh Valley) called attention to the increased use of compressed air for elevating the sand. He considered the practice good in large plants, but

doubted the advantage of its extension to small sand houses.

Wednesday's Sessions.

The second day's work of the convention was devoted to the discussion of the special committee reports read the first day. The first report considered was that of the committee on "Different Methods of Numbering Bridges." The report brought out the fact that a great variety of practice existed in regard to numbering openings in the track. Some railways numbered all openings, some only those above a certain length; some numbered bridges but not culverts, and some did not number anything. A similar variety of practice was shown in the systems of numbering preferred, but generally they were all modifications of the "consecutive" and the "mileage" systems. In the consecutive system the structures were numbered consecutively from unity upward, beginning at one end of the road, and this method was recommended as best by the report. In the mileage system the structure received the number of the mile of line on which it was located with affix letters or fractions for second, third, fourth, and additional structures on that mile. The gist of the report was that bridges and culverts should be numbered and that the consecutive system was preferable.

Mr. Walter G. Berg (Lehigh Valley) opened the discussion by asserting his preference for the mileage system, which he considered more easily comprehended by all classes of employees, and more elastic to admit of the addition and throwing out of structures. Mr. Onward Bates (C., M. & St. P.) stated that he numbered consecutively by divisions, each division having an initial letter. Everything above 6-ft. span was classed as a bridge, and all openings covered by ballast as culverts. Bridges received even numbers and culverts odd numbers, but when a structure was changed from one class to the other it retained its original number. He preferred the mileage system but did not deem it advisable to renumber the 16,000 openings on his line for the advantage. For bridges he used a numbered board, 2 × 12 ins., which was nailed to the end tie, but for culverts the board was fastened to a near-by fence post or telegraph pole where it could be easily seen from a hand-car. Mr. A. McNab (Chic. & W. Mich.) stated that he used the mileage system, with prefix letters to denote branch lines. The number post was driven into the ground 4 ft. or 5 ft. away from the bridge. Besides mile posts his road had station numbers every 500 ft. Cattle guards and culverts were designated as being so many feet from station. Mr. J. H. Travis (Ill. Cent.) stated that all structures were numbered, the numbering being by divisions and by the mileage system. For example, a structure, 565 ft. beyond the 50th mile of division A would be numbered A 50 + 565. The number posts for bridges were sawed diagonally, or from corner to corner, from 6 × 8-in. ties, and painted white with black letters. For culverts a similarly painted 6 × 6-in. cypress post was used. Mr. J. H. Cummin (Long Island) stated that he numbered all bridges consecutively from 1 to 300, all culverts consecutively from 300 upward, and used enameled iron number plates. Mr. Aaron S. Markley (Chic. & Ea. Ill.) preferred the mileage system and used it. Mr. W. M. Noon (D., S. S. & Atl.) used the consecutive system and preferred it to the mileage. Mr. J. O. Olmstead (Cent. Vt.) stated that he numbered all openings over 6-ft. span with 10 × 16-in. board placed on a post 8 ft. from the track. The system was the consecutive but he considered the mileage system preferable. Mr. N. W. Thompson (P., Ft. W. & Chic.) stated that he numbered all openings, but put number plates only on those over 24-in. span. He numbered consecutively, and affixed a letter to the number when additions were made. A cast-iron number plate 2 ft. long and with 6-in. figures, set on a 1½-in. gas pipe post was used. He considered the mileage system to be the better. Mr. W. A. McGonagle (Dul. & Iron Range) stated that he numbered all openings, using the mileage system with affixed letter for second and additional openings, and in case the structure was on a branch he prefixed to the number an initial letter designating that branch. The discussion showed that the majority of opinion was against the preference of the committee report for the consecutive system.

Mr. C. C. Mallard (So. Pac.), a member of the committee on "Draw Bridge and Turntable Ends, Methods of Locking," presented a short report on the subject, the committee as a whole not reporting. The report gave illustrations of a number of such constructions for swing bridges, all of which were of common form, but made no recommendations. In the discussion which followed attention was turned entirely to the locking devices for turntable ends. The principal objection to the ordinary locks was that they could be snapped into place while the table was in motion, thus subjecting it to injurious shocks. A majority of those discussing this point seemed of the opinion that the only good lock was one that could not be closed until the table had been brought to a full stop.

The committee on "Protection of Trestles from Fire" presented no report, but Mr. G. W. Hinman (L. & N.), one of the members, described a system of iron plate protection used by himself with success. In this construction the caps and rail joints were covered with No. 20 galvanized iron plates having their edges lapped down at angles of 45°. With this construction he adopted also the usual precaution of clearing away the grass and weeds from the feet of the trestle bents. In the discussion which followed Mr. Wm. O. Eggleston (Chic. & Erie) stated that he used an iron plate protection, but all of the others, eight in number, who made remarks, stated that their only protection consisted in clearing away grass and weeds and providing water barrels and occasionally watchmen.

The next report was that of the committee on "Local Stations for Small Towns and Villages," and it consisted of 39 plans of actual stations of this type constructed by various railways. The discussion turned upon the best form of platform construction and the advisability of having separate waiting rooms for men and women. For platforms, plank was the most common material, but brick, cinders, stone dust and concrete were also used quite extensively. The general opinion was that the platform should be at rail level or at most only a few inches above the rail. In regard to the number of waiting rooms Mr. J. H. Cummin (Long Island), spoke strongly in favor of the single "combination" waiting room, and stated that this form had been adopted on the Long Island R. R. In these stations the agent's room was separated from the main room by a wire netting or sometimes grill work, so that he could see everything that took place. Smoking and lounging were forbidden. Several other members stated that they used both combination and separate waiting rooms, the choice depending upon the size and conditions. Mr. J. H. Travis (Ill. Cent.) stated that in the Southern states at least two waiting rooms were required by custom and in some states by law, one for colored and another for white people.

The committee report on "Tanks; Frost-proofing, Size, Style and Construction" was next considered, and was substantially as follows:

After considerable correspondence with different members of this association we find that most roads use the standard 16 × 24-ft. tank, with a capacity of 50,000 gallons. These tanks are placed on various styles of substructures, some of which are oak, others pine; but the most up-to-date substructure is that made of steel, which we find quite a number of roads have adopted or are about to adopt. As for frost-proofing, some roads box up their pipes with brick-work, others use lumber, which is considerably cheaper and answers the purpose nearly as well. Where it is exceedingly cold during the winter it is good policy to house in the substructure and keep a fire under the tank, allowing the smoke and heat to pass through a pipe near the valve in tank and out through the roof of the tank. In this case it may be necessary to ceil over the upper joists in order to hold the heat from the stove as much as possible. There is an old saying that "The best is the cheapest," and it will hold good in this case, and your committee desire to offer the following: That a first-class white pine tank, placed at an elevation of 25 ft. above rail on a steel substructure and stone foundation and connected with a 12-in. pipe to a 10-in. stand-pipe, is the most economical and modern structure of the kind at the present time.

The report also presented itemized figures of cost of three standard tanks. A 16 × 24-ft. white pine tank and tower on the Chicago & West Michigan R. R. cost $973.80, of which $228 were for stone foundation, $161.37 for labor of erecting, $25.50 for labor of painting and the remainder for material. A 20-ft. cypress standard Lehigh Valley R. R. tank cost $896.77, of which sum $280 were for masonry and $175 for labor. The Chicago, Rock Island & Pacific R. R. standard tank costs as follows:

16 × 24-ft. tank with 12 hoops, 3 lugs each	$275.00
1 indicator	5.00
1 set 7-in. fixtures	68.00
12 iron post caps	24.00
Rail joists, at $5 per ton	18.45
Substructure, frost proofing, etc.	198.36
Paint	14.51
Foundation stone	68.75
Labor in foundation	116.00
Labor, painting	24.24
Labor, erecting tank	164.72
Total	$973.03

The discussion which followed was quite extended, but few facts differing from those in the report were presented. Mr. W. A. McGonagle (Duluth & Iron Range) stated that in a climate which often presented a temperature of — 50° F. to — 60° F. he used a 16 × 24-ft. tank made of 3-in. cypress, with timber tower and masonry piers on an 18-in. concrete foundation. The tank was placed at the extreme edge of the right of way and a stand-pipe was used. The pipe from the pump to the tank was boxed in and carried on a trestle above ground. The pipe box was made of boards and tar paper with three dead air spaces, and through it passed a ¾-in. steam pipe from the boiler. With this construction no trouble was had from freezing. Mr. M. Riney (Chic. & N'wn) gave the costs of three 16 × 24-ft. white pine tanks recently built as: (1) labor $352, material $955, total $1,307; (2) labor $433, material $1,671, total $2,104; (3) labor $467, material $1,715; total $2,182. These figures included cost of everything.

The next report considered was that of the committee on "Best and Uniform System of Records for Bridge and Building Department." It was in abstract as follows and was not discussed:

We have received from a number of roads copies of forms used by them, and find that with the exception of time books, there is a great diversity of forms and methods of reporting. In many cases the forms are for general use of the various departments of the system, and seem to be prepared to suit the general accounts, and also indicate that the statements required of expenditures on bridges and buildings differ in almost every instance. Therefore, on account of the various conditions under which bridge and building department work is performed on the different systems, and by reason of the fact that in many cases the forms are adapted to general use, and that any change might affect the general accounts, we have deemed it best to recommend only the following forms, and have arranged and classified all the other forms submitted so that they may be examined by the members and notes taken of such as are suited to their respective roads. The forms recommended are: Time Book to be 4½ ins. × 7 ins., and the number of leaves to be varied in accordance with the size of the crew. Covers to be oil boards with cloth back. This book is recommended because it shows the over-time. It is intended that it shall be in use one month only, and retained in the office of the person making the distribution of time. For reporting material used, Mechanics' Diary, U. P. system, the number of pages in the book to be determined by the road using it. Bridge and Building Record Account Book, the C., M. & St. P. Ry. system, which is to record in an ordinary journal-ruled book the charges to the work as they appear in the monthly distributions of labor and material, and when the structure is completed to analyze the cost. In our opinion the above forms are the best, and can be adopted by any of the roads submitting forms without any serious alteration in their methods of reporting.

No discussion followed the next report, which was that of the Committee on "The Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges." The committee announced its inability to present anything new on the subject, but briefly summarized some of the experiments made in the past and already familiar to the readers of Engineering News.

Mr. G. W. Hinman (L. & N.) presented an individual report upon the "Best and Most Economical Railway Track Pile Driver," the committee as a whole not reporting. Mr. Hinman described the pile driver used on the Louisville & Nashville R. R. The driver is of a pendulum form and capable of driving piles either plumb or at any batter. It has two centers so that piles can be driven close to either end of the car or 15 ft. from the forward end of the car. A double-action 7-in. cylinder Lidgerwood engine with two friction drums and two winch heads operated a 3,300-lb. hammer by the frictions. The hammer rope is a 2½-in. manila and is made fast to the hammer. On the driver is a water tank of 300 gallons capacity and a coal box of 25 bushels capacity. Accompanying the driver is a locomotive and tool car. One end of this car is boxed in for 24 ft., but the remaining 10 ft. is left open for a hand-car, pile rings, and coarse tools. The cost of running this driver per day is as follows:

Foreman and ten men	$22.00
Engineer, fireman and watchman	6.80
Conductor and flagman	7.00
Coal, oil and waste	2.50
Use of locomotive	12.00
Use of driver and tools	2.50
Total	$52.80

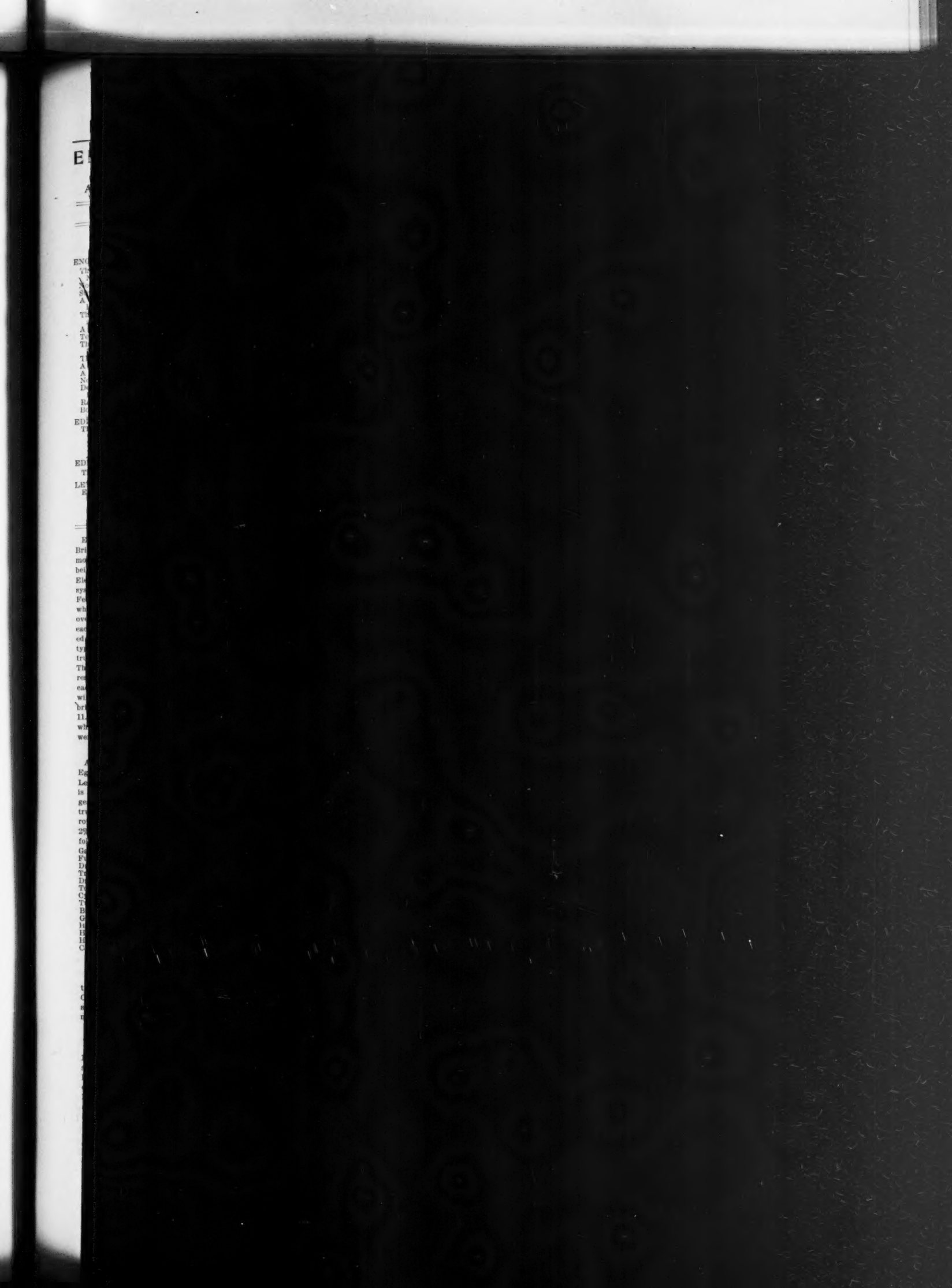
For long trestles of from 3,000 ft. to 4,000 ft. the gang is enlarged to a foreman and 14 men.

In the discussion which followed a number of members spoke in favor of the self-propelling pile driver made by the Bay City Industrial Iron Works, but Mr. N. W. Thompson (P., Ft. W. & Chic.) stated that it had proved unsatisfactory on his road. The general opinion was that manila or "stevedore" rope was better for hammer lines than iron or steel wire cables. This discussion was followed by several business committee reports which concluded the proceedings of the second day's session.

Thursday Morning Session.

The session of the association on Thursday morning was devoted to the election of officers, selection of next place of meeting, adoption of resolutions and the discharge of routine business. The following named officers were elected: President, James Stannard, Wabash R. R., Kansas City, Mo.; First Vice-President, W. G. Berg, Lehigh Valley R. R., Jersey City, N. J.; Second Vice-President, J. H. Cummin, Long Island R. R., Long Island City, N. Y.; Third Vice-President, A. H. Markley, Chicago & Eastern Illinois Ry., Danville, Ill.; Fourth Vice-President, R. M. Peck, Missouri Pacific Ry., Pacific, Mo.; Secretary, S. F. Patterson, Boston & Maine R. R., Concord, N. H.; Treasurer, N. W. Thompson, Pittsburg, Ft. Wayne & Chicago R. R., Ft. Wayne, Ind.; Executive Committee, W. N. Noon, Joseph M. Staten, W. O. Eggleston, M. Riney, C. P. Austin and G. J. Bishop.

Resolutions were adopted expressing the obligations of the convention, for favors shown by the Illinois Central and Santa Fe railways, the Pullman and Wagner companies, the mayor and the city of Chicago, the Western Railway Club, the Patterson-Sargent Co., the Sherwin-Williams Co., the technical press, and the local committee of arrangements. At noon the convention adjourned to meet in Denver, Colo., on the third Tuesday in October, 1897.

Excursions and Entertainments.

On Thursday afternoon a visit was made to the Burnside shops, Illinois Central R. R. (Eng. News, June 18, July 16 and 23, 1896), and to the town of Pullman. On Friday a number of the members made a trip along the Chicago Drainage Canal. A theater party and other entertainments were provided for the members by the Patterson-Sargent Co., of Chicago, and the Sherwin-Williams Co., of Cleveland, O.